TECNAIR LV
CLOSE CONTROL AIR CONDITIONING

INSTALLATION, USE AND MAINTENANCE MANUAL

SCOPE OF THIS MANUAL

SERIES H DIRECT EXPANSION
AND CHILLED WATER
AIR CONDITIONERS

Lifeline

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"VERSIONE ORIGINALE"

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1 HOW TO USE THIS MANUAL

This manual describes the procedures for the installation, use and maintenance of series H air conditioning units.

The following chapters contain information essential for obtaining the best performance from the unit you have purchased; TECNAIR LV therefore recommends that you study this manual carefully.

Some of the topics covered in this manual refer to the functions of the microprocessor controls; TECNAIR LV therefore advises you to read the MICROPROCESSOR CONTROL USER MANUAL, which is also supplied with the unit, in order to gain a full understanding of the components and functions of your air conditioner.

If after reading this manual you are still experiencing difficulties or require any further clarification, please do not hesitate to contact our after-sales service:

After-sales office
Tel. +39029699111 / Fax +390296781570

1.1 IMPORTANT WARNINGS

The equipment described in this manual has been constructed to operate without risk for the intended purposes, provided that:

- The installation, connection, operation and maintenance of the appliance are carried out by qualified personnel in accordance with the instructions contained in this manual.
- All the conditions prescribed in the user manual for the unit's microprocessor control are observed.

Any other use or modification of the equipment, unless expressly authorised by the manufacturer, is deemed improper.

Any injuries or damage sustained as a result of improper use shall be the sole responsibility of the user.

2 WARRANTY

TECNAIR LV air conditioners are subject to the following warranty conditions which are automatically deemed to have been understood and accepted by the customer at the time of placing the order.

TECNAIR LV guarantees that the products supplied are well made and of good quality. It undertakes during the period of warranty specified herein to repair or to replace with new at its own discretion, in the shortest time possible, those parts found to present recognised defects in materials, construction or workmanship that render them unfit for the intended use, provided that these faults are not the result of negligence on the part of the purchaser, neglect or inexperience of the user, normal wear and tear, damage caused by third parties, acts of God or other causes not arising out of manufacturing defects. TECNAIR LV however shall not be liable to for compensation for direct or indirect damage of any nature incurred for any reason.

Defective components will be replaced at the Uboldo manufacturing plant, and all transportation and replacement costs shall be borne by the Purchaser.

The duration of the warranty is 2 (two) years from the date of consignment.

The warranty shall be rendered void automatically if the equipment is repaired or modified or in any way completed (such as, for example, in the case of non-supply of an electrical panel or similar) or in the case of the installation of non-original parts (parts not supplied by TECNAIR LV).

The above warranty conditions apply provided that the Purchaser has fulfilled all contactural obligations and in particular those reagarding payment.

3 DESCRIPTION OF THE UNIT

The machine in question is an air conditioner with direct expansion or chilled water coil for surgical rooms and medical environments.

The H series is characterised by perfect air-tight sealing, TUV certified and meeting class “B" requirements of EN 1886. The cabinets are made of steel sheet with all joints welded and sealed with mastic. The cabinets are painted in epoxy resin and oven cured at 150°C, after sandblasting, metalization and application of epoxy primer. The runners for battery removal and all friction points are made from AISI 304 stainless steel. The buffer panels are 25 mm thick with twins walls separated by thermal and accoustic insulation. The openable front panels are hinged and fitted with key locks. The electrical panel is equipped with an emergency safety switch.

A version for outdoor installation (accessory) is also available; the outdoor version is equipped with an anticondensation heater on the electrical panel, a microprocessor control protected from sunlight by a double access panel to the electrical panel and a rain canopy. The buffer panels are of twin-wall construction with a thickness of 50 mm.

The machine comprises the following sections:

- Electrical power and control panel
- Ventilation section: consisting of one or more electric Plug fans mounted to the machine frame
- Air treatment section:
- Refrigeration circuit (Series A): comprising an expansion coil with copper prepainted aluminimum cooling fins, a scroll compressor fixed to the machine frame on rubber mountings, thermostatic expansion valve, receiver-drier, plate-type condenser (accessory), low pressure switch (automatic reset) and high pressure switch (manual reset).
- Water circuit (Series U): with cooling expansion coil with copper pipes in prepainted aluminium cooling fins, 3-way motorised valve with manual emergency control, water circuit with anti-condensation thermal insulation
- Heating and post-heating water coil with cooling coil with expanded copper pipes within prepainted aluminium finning, 3-way motorised valve with emergency manual control; or electric low-thermal inertia with modulation triac
- Immersed electrode humidifier or modulating mains steam valve

3.1 UNIT CODE

The code contains the following information:

O	H	A	5	1	a	H	R407C	HR
1	2	3	4	5	6	7	8	9

1	**O**	Upflow air discharge
2	**H**	Series for surgical rooms or medical environments
3	**A**	Cooling type: **A** Direct expansion coil with remote condenser **U** Chilled water coil with remote cooling
4	**5**	Nominal size (nominal cooling capacity in TONS)
5	**1**	Number of cooling circuits or number of rows on chilled water coil
6	**a**	Series modification index
7	**H**	Air flow rate/cooling capacity ratio **H** High air flow rate **L** Low air flow rate
8	**R407C**	Refrigerant type
9	**HR**	Air conditioner equipped with heat recovery system (if present)

3.2 OPERATING LIMITS

SERIES H AIR CONDITIONING UNITS

UNIT TYPE	DIRECT EXPANSION				CHILLED WATER	
CHARACTERISTICS	WITHOUT HEAT RECOVERY		WITH HEAT RECOVERY		WITHOUT HEAT RECOVERY	WITH HEAT RECOVERY
	L	H	+L	H		
MAXIMUM TEMPERATURE	38°C	30°C	46°C	40°C	38°C	46°C
MINIMUM TEMPERATURE	-22°C	-10°C	-40°C	-32°C	-22°C	-40°C
MAXIMUM HUMIDITY	95%	95%	95%	95%	100%	100%
MINIMUM HUMIDITY	10%	10%	10%	10%	10%	10%
STORAGE CONDITIONS	Temperatures from -20°C to +50°C					

CONDENSERS AND DRY COOLER

UNIT TYPE	AIR		WATER	
CHARACTERISTICS	WITH VARIATOR	WITHOUT VARIATOR	WITH PRESSURE CONTROLLED VALVE	WITHOUT PRESSURE CONTROLLED VALVE
MAXIMUM TEMPERATURE	Up to 30°C: ΔT = 17°C Up to 35°C: ΔT = 15°C Up to 40°C: ΔT = 13°C Up to 46°C: ΔT = 10°C		45°C	
MINIMUM TEMPERATURE	-25°C	-40°C	7°C	25°C

WATER CIRCUITS

TYPE	CHILLED WATER	HOT WATER	INTERNAL HUMIDIFIER	MAINS STEAM
MAXIMUM PRESSURE	16 bar (1.6 Mbar)	8.5 bar (0.85 Mbar)	8 bar (0.8 Mbar)	1 bar (0.1 Mbar)
MINIMUM PRESSURE	-	-	1 bar (0.1 Mbar)	0.2 bar (0.02 Mbar)
MAXIMUM ΔP AT VALVE	1 bar (100 Kpa)	1 bar (100 Kpa)	-	-
MAXIMUM TEMPERATURE	-	85°C	40°C	152°C
MINIMUM TEMPERATURE	5°C	-	1°C	-

4 INSTALLATION PROCEDURE

4.1 TRANSPORTATION

Unless otherwise agreed with the Customer, TECNAIR LV shall supply their machines ex works with standard packaging consisting of a wooden pallet and protective polythene sheet.

During transportation the machines must not be laid on their sides or overturned but must remain in the vertical position at all times otherwise their internal components could be damaged.

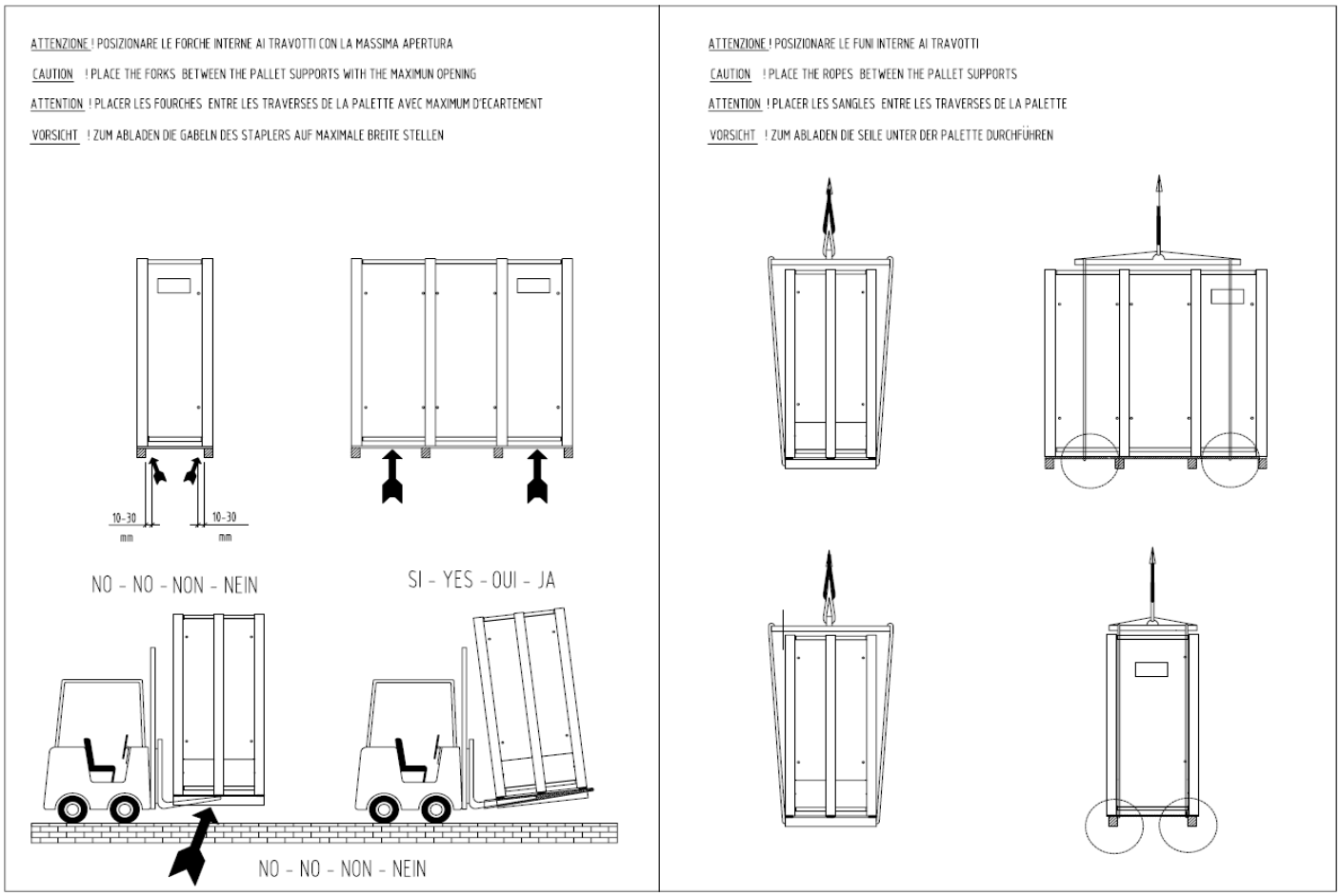
As the Carrier is always responsible for damage sustained during transport by the goods, before signing the delivery note to accept the supply, check the integrity of the packaging and that there are no visible signs of damage to the conditioner or the leakage of oil or refrigerant.

In the case of evident damage to the unit or if there is slightest doubt as to whether the conditioner has been damaged during transport, it is necessary to express your reservations in writing to the Carrier, whilst also informing the TECNASIR LV Sales Department.

4.2 RECEIVING THE MACHINES ON SITE

For unloading of the units, please observe the procedures indicated in the illustrations reproduced below, which are also affixed to the original packaging of the unit.

If the unit is not to be installed immediately after its arrival on site, it should remain in its original packaging and stored in a dry, enclosed area, preferably heated to a temperature of 15°C during the winter months.



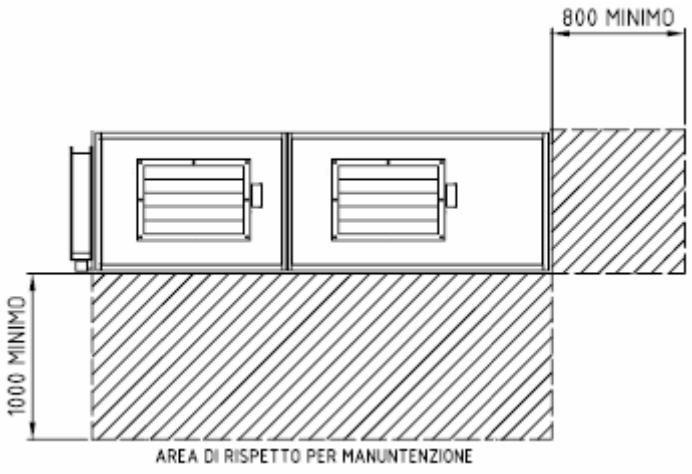
4.3 POSITIONING THE UNIT AND CLEARANCES

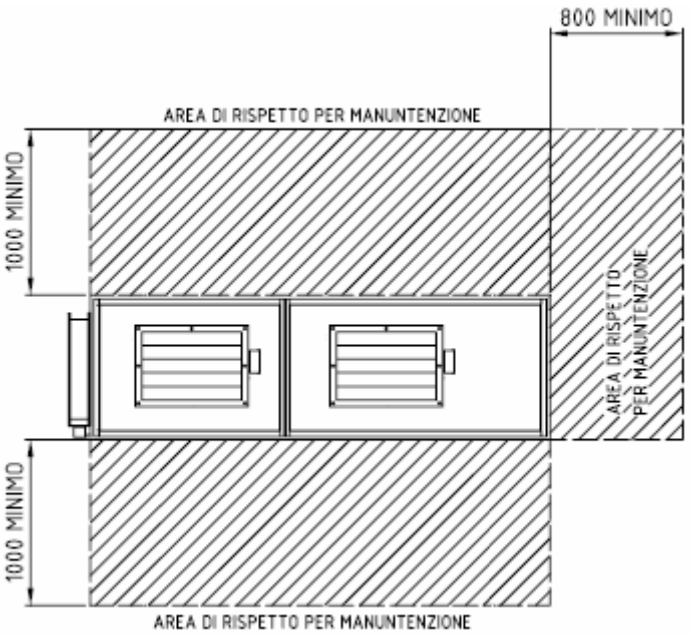
To avoid any problems and damage to the air conditioners during transportation, we recommend that the units should only be removed from their packaging when they have reached their final destination.

It also essential to make sure that the floor on which the air conditioner is to be installed is capable of supporting its weight. The weight of the unit can be found in the commercial documentation or read directly from the data plate located inside the unit.

During installation, respect the clearances required for routine and major servicing indicated in the drawing enclosed with the order confirmation.

In general and in any case it is essential to allow a space of approximately 1000 mm along the full length of the front of the machine and 800 mm on the right-hand side; for units with rear opening, a free space of 1000 mm should be provided along the full length of the rear of the machine.

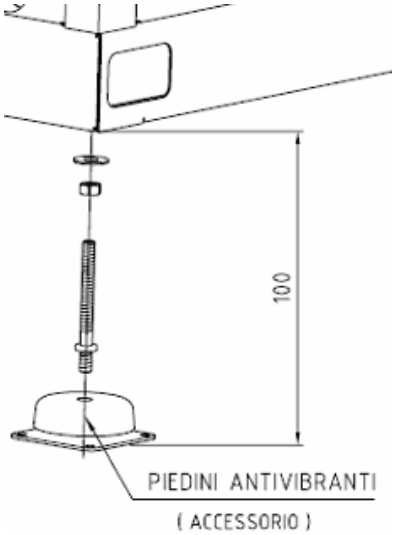




4.3.1 SHOCK-ABSORBING FEET

Before final positioning, install the shock absorbing feet supplied with the unit (accessory).

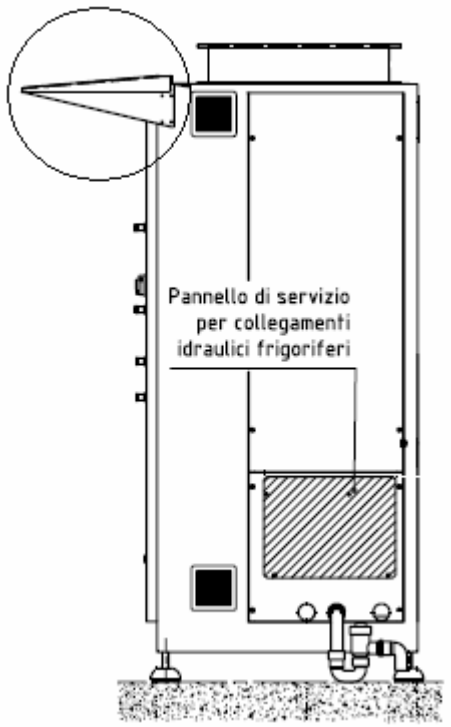
The feet are to be fixed to the underside of the unit using the bolts provided, as shown in the drawing enclosed with the order confirmation.



4.3.2 RAIN CANOPY

Outdoor units are supplied with a rain canopy that is to be installed by the user. The rain canopy is to be fixed to the top of the unit, as shown in the drawing enclosed with the order confirmation.

This canopy, while protecting the front of the unit from rain, does not guarantee safe servicing during inclement weather. Therefore TECNAIR LV recommends that the unit is positioned under a further canopy to provide shelter during any technical operations that may be required.



4.4 WATER CONNECTIONS

WARNING!

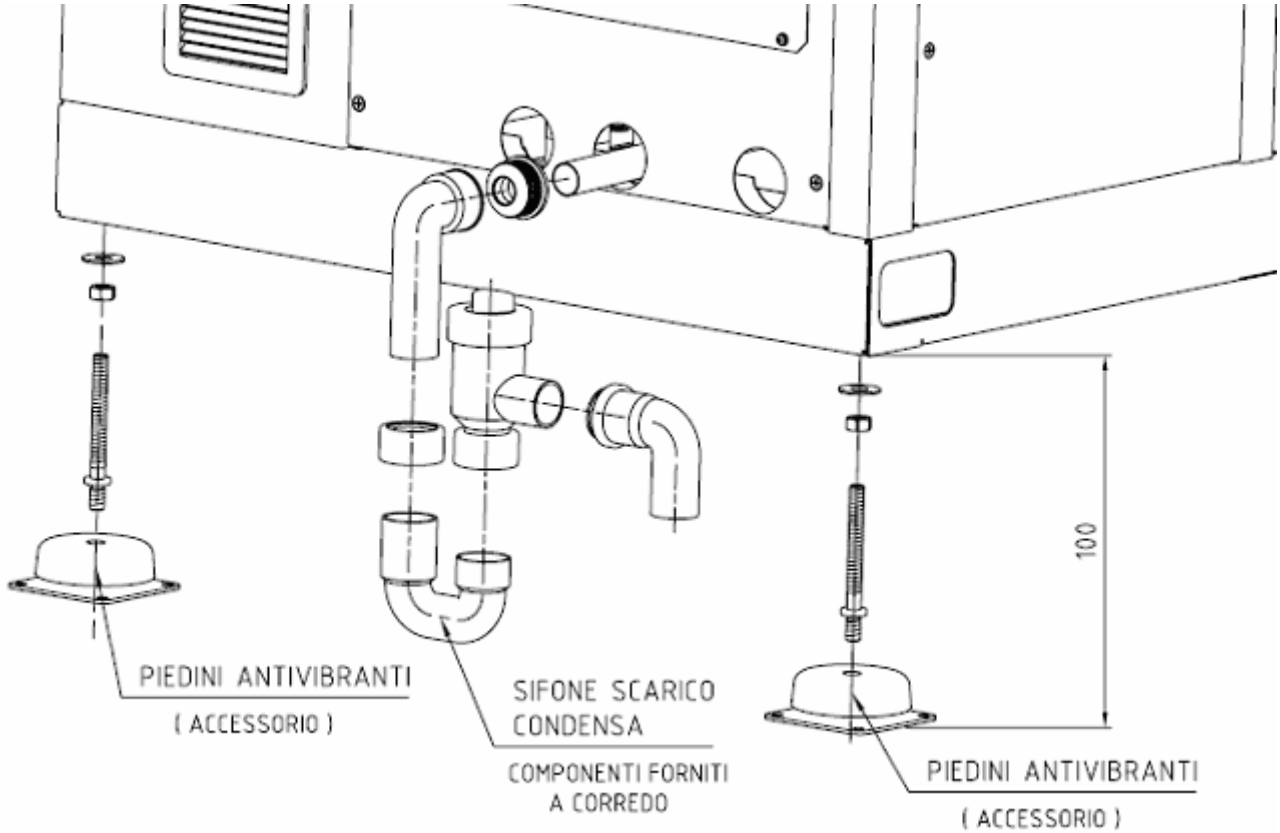
TECNAIR LV tests water components with dried compressed air at 24 Bar. This ensures that no water is present in the water circuits thereby preventing the possibility of freezing during storage prior to installation.

However, during the positioning and installation operations, it is essential to take special care not to fill the water circuits, even accidentally, before all the necessary antifreeze measures stipulated in the design spefications have been taken (e.g. insulation, addition of glycol, etc.).

4.4.1 CONDENSATE DRAIN AND SIPHONS

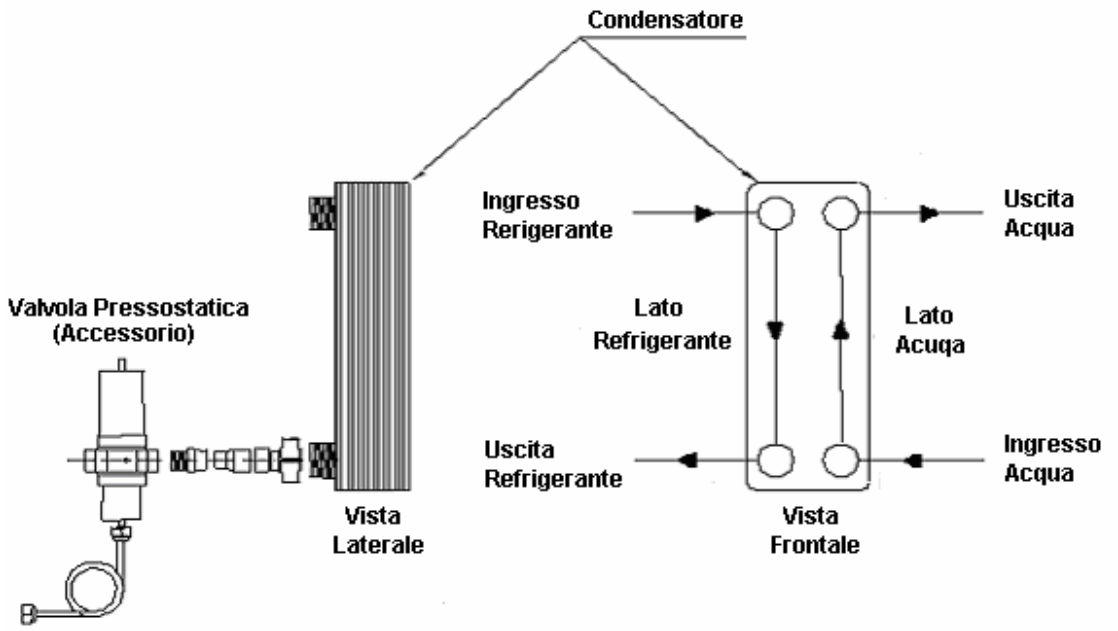
All air conditioners, whether direct expansion or water chilled coils, require a condensate drain connection between the machine and the building waste drains system and the humidifier drain.

The siphon, essential for draining condensate as the relative bowl is located in a point of negative pressure, is included in the supply and is to be installed when the unit the is placed in position.



4.4.2 WATER-COOLED CONDENSERS

On machines with integral water-cooled condensers, it will be necessary to install the supply and drain lines to the condenser. The diameters of the pipes and the inlet and the outlet unions are indicated in the order confirmation. The water inlet unions on the plate-type condenser used by Tecnair are those at the bottom, while the outlet unions are at the top, as shown in the figure below.

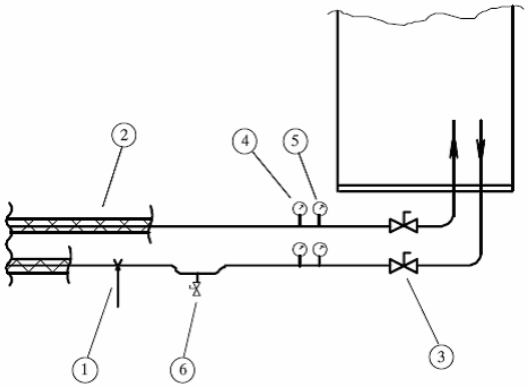


The pressure controlled valve (accessory) is essential when the water is supplied from a well, river or acqueduct; it is not essential when the water is supplied from a water tower. In practice, the valve is necessary when water during winter can enter at such low temperatures (e.g. below 15 degrees) that the machine's condensation temperature is lowered excessively. The valve is factory-installed on the condenser water inlet.

If the water supply is obtained from a well or river, two filters of suitable characteristics for the type of water must be installed in parallel, (one as backup for the other) to prevent the condenser from becoming clogged by impurities in the water.

To ensure that circuit pipes are installed correctly, we recommend that the following indications are observed:

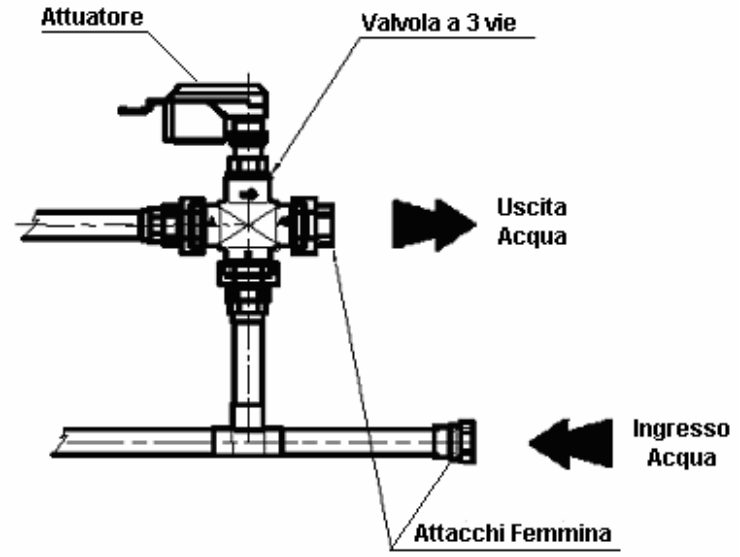
- Use pipes made of copper or steel
- Support pipes with suitable brackets (1)
- Insulate both pipes with Armaflex type insulation (2)
- Install shut-off valves to facilitate maintenance (3)
- Install a Thermometer (4) and Pressure gauge (5) on the inlet and outlet
- Install a drain outlet in the lowest part of the circuit (6)
- Use a water/glycol solution where necessary



4.4.3 WATER COILS

For machines with chilled water coils, as for those with hot water coils, it will be necessary to install inlet and outlet pipes. The diameters of the pipes and the inlet and the outlet unions are specified in the order confirmation.

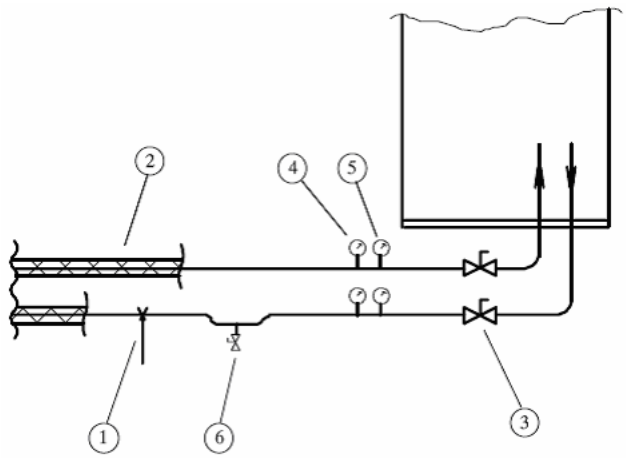
The water inlet and outlet unions are indicated in the figure below. The unions can also be identified by their adhesive labels.



The maximum pressure of the water supply to the coils is 16 bar (1.6 Mpa). The maximum pressure difference between the water inlet pipe and the outlet pipe is 1 bar (100 kPa), as at pressure differences greater than this value the return spring would not be able to shut off the water flow. In the event of greater pressure differences, it will be necessary to install a pressure reducing valve upstream of the 3-way valve.

To ensure that circuit pipes are installed correctly, we recommend that the following indications are observed:

- Use pipes made of copper or steel
- Support pipes with suitable brackets (1)
- Insulate both pipes with Armaflex type insulation (2)
- Install shut-off valves to facilitate maintenance (3)
- Install a Thermometer (4) and Pressure gauge (5) on the inlet and outlet
- Install a drain outlet in the lowest part of the circuit (6)
- Use a water/glycol solution where necessary



4.4.4 HEAT RECOVERY CIRCUIT

TECNAIR LV does not fill the heat recovery circuit in the factory as the percentage of glycol to be added to the water will vary according to the installation site and the minimum winter temperature.

It essential to use a water/glycol solution whenever there is the possibility that the outside temperature may fall below zero degrees. When filling the circuit, always add the glycol first, then the water.

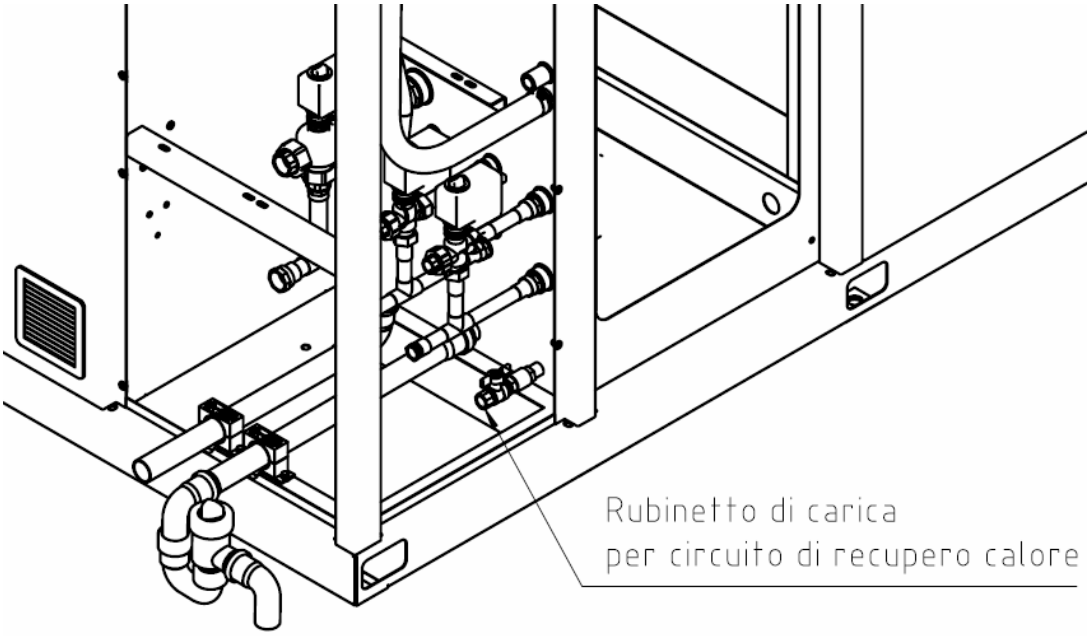
If the system is stably connected to the mains water supply, a shut-off cock must be installed upstream of the mains connection.

A manual drain cock for the circuit is provided under the expansion vessel.

Below are indicated the total capcities in litres of the air conditioner heat recovery circuits:

- 36 litres for model sizes 62 to 138;
- 48 litres for model sizes 152 to 208;
- 67 litres for model sizes 242 to 308;

Remember that if the circuit is filled with a water/glycol solution, it must not be drained into the main sewer.



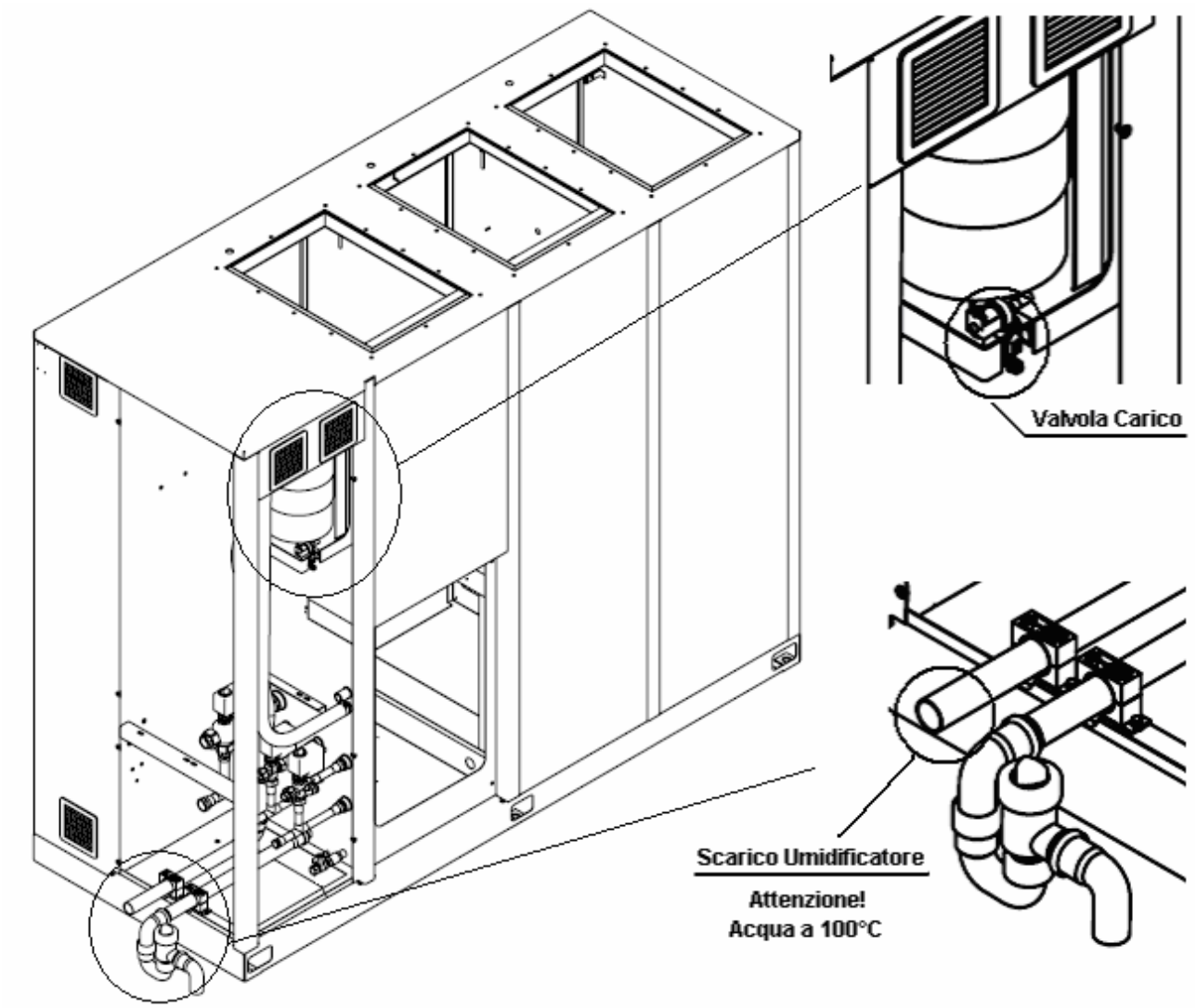
4.4.5 INTERNAL ELECTRODE HUMIDIFIER

During installation of the unit it is necessry to connect a supply pipe (as shown in the figure) with the system characteristics indicated below. The discharge pipe is supplied ready-installed by Tenciar LV.

The following conditions for correct water connection should be met:

- A shut-off cock must be installed in the water supply pipe
- There must be a mechanical filter installed on the supply line
- The water temperature and pressure must be within the permitted value range

For more information of the characteristics of the humidifier water circuit, please refer to the User manual for the internal humidifier.



4.4.6 MAINS STEAM VALVE

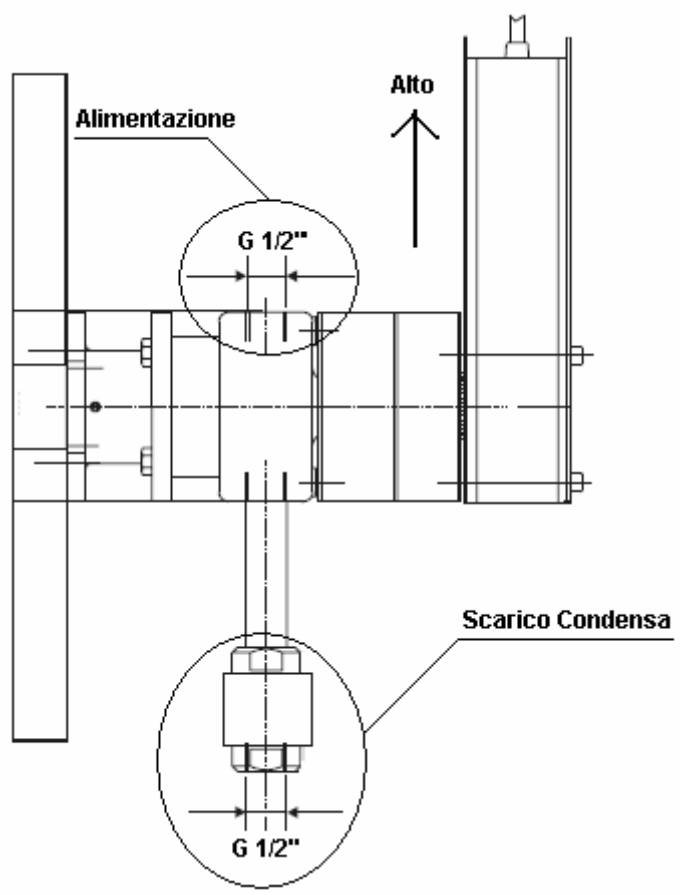
The steam distribution systems may be connected to boilers, steam heat exchangers or existing steam users.

The steam supply pipe, perfectly drained, must be connected to the top of the unit, as shown in the drawing, so that there is downward gradient towards the humidifier. A shut-off damper (to be supplied by the installer) must be installed upstream of the system. We recommend using a pressure gauge.

The steam supply pressure must be as stable as possible and within the range of 0.2 and 1 bar relative pressure. If the pressure exceeds this value, the installer must provide a pressure reducer to adapt the system to the steam distribution system.

The steam supply and condensate drainage must be constructed from suitable materials. Joints, seals and flanges must be capable of withstanding temperatures of up to 152°C according to the supply pressure.

Drainage of the steam mains pipe under pressure must be achieved efficiently.



4.5 REFRIGERANT CIRCUIT CONNECTIONS

The pipes must be made from Gelidus type copper, soft annealed copper for pipes with diameters 26 - 28, and hard drawn for larger diameter pipes.

To prevent copper dust or swarf from getting into the system, the pipes should be cut using a pipe cutter rather than a hacksaw. The ends of the pipes should then be carefully cleaned.

If the ends are to be soldered, they should be cleaned with grade 00 glasspaper to eliminate all oxidisation and dirt. After which the pipe should be inserted in the joint and heated evenly to the melting point of the solder so that flows easily around the joint.

It is important to remember that the pipes should be as short as possible with bends kept to a minimum, as the cooling capacity of the circuit can be summarised as follows:

Total length of the pipes (discharge and return):

- > 20 m: - 2%
- > 40 m: - 4%
- > 60 m: - 6%

4.5.1 DISCHARGE OR HOT GAS LINE

This is the refrigerant line that connects the compressor outlet to the air-cooled condenser inlet.

To facilitate connection inside the air conditioner, there is a section of pipe approximately 20 cmm long with one end connected to the compressor outlet and pinched and soldered shut at the other end.

During operation of the air conditioner, the discharge pipe reaches a temperature of 70 - 80°C. Thermal insulation of this pipe is not necessary as dispersion of heat along this section favours the refrigeration cycle. The pipes should only be insulated for safety reasons in cases where there is a possibility that someone could come into accidental contact with the discharge pipe.

4.5.2 LIQUID OR RETURN LINE

This is the pipe that conects the condenser outlet to the air conditioner inlet valve.

It is connected by soldered joints to the condenser and to the inlet valve. The operating temperature of this pipe is about 40°C; it does not need to be thermally insulated except in cases where the air conditioning system is also to operate in winter with temperatures below zero.

4.5.3 NON-RETURN VALVES ON DISCHARGE AND RETURN LINES

WARNING!

In installations with refrigeration circuit pipes longer than 10 metres with vertical pipe runs and the condenser located higher than the machine, it will be necessary to install a non-return valve on the refrigerant discharge pipe as near as possible to the compressor outlet.

This will prevent the refrigerant, in the event of the compressor shutdown, from flowing back down the discharge pipe to the compressor and thus damaging it at the next startup and/or preventing normal operation by causing a high-pressure blockage. Naturally the valve must be installed vertically and the right way round in accordance the refrigerant direction of flow.

In the case of pipe sections more than 20 m long and expected minimum temperatures below –10°C it will be necessary to install another non-return valve at the outlet of the air condenser, and as close to it as possible; the valve should be installed vertically to prevent the refrigerant from flowing back to the condenser when the system is off and the external temperature is very cold, and thereby preventing efficient condensation of the refrigerant the next time the compressor is started.

4.5.4 VERY LOW EXTERNAL TEMPERATURE KIT

CEA air condensers, combined with Tecnair LV direct expansion air conditioners, are equipped as standard with air condensation pressure control via reduction of the air flow rate in accordance with the reduction in the condensation pressure. This system is very effective with external temperatures down to –20°C, thanks also to a few seconds delay before the low pressure switch trips at compressor startup. At external temperatures below this level and above all in the case of lengthy periods of non-use of the refrigeration circuit, the temperature of the liquid refrigerant can become so low that, in spite of the above-mentioned delay, the low pressure switch trips on compressor startup, thus making starting impossible.

To avoid this problem, we recommend the “very low temperature kit”, comprised of a condenser flooding valve installed on the refriegerant connections of the air condenser.

When the condensation temperature falls below +40°C, the valve progressively closes the condenser outlet, thereby flooding it and reducing proportionally the heat exchange. The refrigerant that bypasses the condenser is gaseous and at high temperature; it mixes with the liquid refigerant at very low temperature at the condenser outlet, so that the resulting temperature is such to permit the successful system startup. The volume of refrigerant present in the circuit must therefore be sufficient to be able to almost completely flood the condenser coil. During summer operation instead, the condenser coil must be almost completely free of liquid refrigerant in order to operate correctly. An oversize receiver is therefore installed in order to accommodate in summer the quantity of refrigerant that is required in winter to flood the condenser.

4.5.5 SOLENOID VALVE ON THE LIQUID LINE

The scroll compressors installed on TECNAIR LV air conditioners will not be damaged by the presence of any liquid refrigerant in the crankcase. However, when the refrigeration ciruit is shutdown in the summer season, i.e. when the external temperature is just a few degrees higher than the internal temperature, the liquid refrigerant flows towards the compressor (the coldest point of the circuit) and, depending on the quantity of refrigerant in the system, floods it partially or completely. In this case, the high pressure switch may trip at the next startup.

It is therefore necessary to compare the refrigerant charge in the circuit, calculated as the sum of the contents of the various components of the circuit, with the maximum quantity compatible with correct operation without the solenoid valve on the liquid pipe, as indicated in the table below.

Size	Compressor		Maximum quantity of refrigerant (kg)
	Rated power (Hp)	Rated power (kW)	
21	2	6	2,8
31	3	10	3,6
41	3,5	11	5,4
51	5	15	5,4
71	6,5	19	5,4
81	7,5	25	7,3
101	10	30	10,0
131	12	36	12,5
151	15	45	13,5

Table of maximum compatible refrigerant quantities per circuit without installation of solenoid valve on liquid pipe.

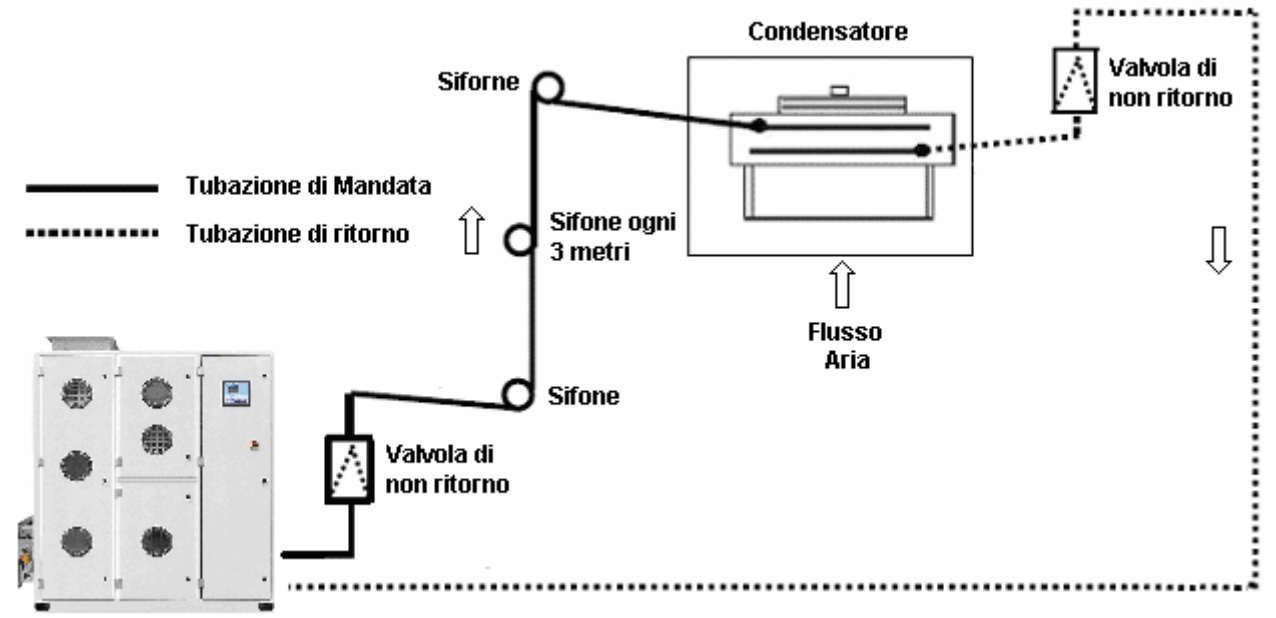
In the case that the calculated charge is greater than the maximum compatible quantity, it will be necessary to order the “liquid pipe solenoid valve” accessory which, by closing when the compressor is shut down, prevents the refrigerant flowing back towards the compressor through the liquid pipe.

Obviously it is also necessary to prevent refrigerant from flowing back to the compressor through the discharge line. This is achieved by installation of the non-return valve on the discharge line. The latter valve, unlike the solenoid valve, is not offered by TECNAIR LV as an optional accessory as it must be installed when the refrigeration circuit external to the machine is installed, while the solenoid valve is installed inside the machine itself.

4.5.6 ROUTING OF THE REFRIGERANT CIRCUIT PIPES

Correct routing of the refrigerant circuit pipes is essential to the successful operation of the air conditioner. It is necessary to take special care in the selection and positioning of the compressor discharge and suction pipes, above all when these lines are relatively long and in particular:

- Horizontal sections of discharge pipes between the inside and outside components must have a gradient of at least 2% in the direction of refrigerant flow.
- If the discharge pipe has to rise above 3 m, a siphon with the minimum radius bend possible must be installed immediately before each rising section.
- Additional siphons must be provided every 3 m of rising pipe.
- Position a counter-siphon near the condenser union. The counter-siphon must be at least as high as the highest part of the condenser coil;
- All pipes must be secured with brackets every 2 metres. The pipe supports should prevent transmission of vibration and at the same time allow for normal expansion and contraction of the pipes due to temperature changes during operation.
- A 1/4" service valve must be installed on both pipes, as near as possible to the outside unit, to allow draining and charging of the circuit.
- The refrigerant inlet and outlet unions on the air-cooled condenser can be identified by their adhesive labels. In any case, note that the exchange of heat between the air and the refrigerant should occur in the opposite direction to the flow. This means that the condenser inlet union for the gaseous refrigerant is the union furthest from the air inlet into the coil, i.e. the union nearest the fans. Likewise, the condenser outlet union for the liquid refrigerant is the union furthest away from the fans.



4.5.7 DIAMETERS OF REFRIGERANT CIRCUIT CONNECTION PIPES

Use the following table to determine the recommended diameters for the discharge, liquid and suction pipes in accordance with the machine size (given by the numerical sequence in the product code).

The values in the columns for pipe lengths up to 30m are also valid for longer lengths and do not need to be increased. However, it is advisable to position the air conditioners so that the pipes are kept as short as possible, to avoid significant loss of charge in the circuit and a consequent reduction in cooling capacity.

Size	Compressor		Pipes up to 15 m long			Pipes 15 to 30 m long		
	Rated power (Hp)	Rated power (kW)	Discharge	Liquid	Suction	Discharge	Liquid	Suction
51	5	15	16/18	10/12	26/28	20/22	14/16	26/28
81	7,5	25	20/22	14/16	26/28	26/28	14/16	33/35
101	10	30	20/22	14/16	33/35	26/28	16/18	33/35
151	15	45	26/28	16/18	33/35	26/28	20/22	39/42
102	2×5	2×15	2×16/18	2×10/12	2×26/28	2×20/22	2×14/16	2×26/28
132	2×6,5	2×19	2×16/18	2×10/12	2×26/28	2×20/22	2×14/16	2×33/35
152	2×7,5	2×25	2×20/22	2×14/16	2×26/28	2×26/28	2×14/16	2×33/35
202	2×10	2×30	2×20/22	2×14/16	2×33/35	2×26/28	2×16/18	2×33/35
242	2×12	2×36	2×26/28	2×16/18	2×33/35	2×26/28	2×16/18	2×39/42
302	2×15	2×45	2×26/28	2×16/18	2×33/35	2×26/28	2×20/22	2×39/42

Inside/outside diameters of refrigerant pipes

4.5.8 REFRIGERANT CHARGING

- **Direct expansion air conditioners are shipped without refrigerant charge.**
- **Air-cooled condensers are shipped without refrigerant charge.**
- **Machines with internal water-cooled condensers are supplied fully charged with refrigerant**

To charge the refrigerant circuit/s of a machine, it is necessary to consider that the total quantity of refrigerant required for a direct expansion unit equipped with remote condenser is determined by the sum of the refrigerant contents of:

The air conditioner:

Size	Compressor		Contents of refrigerant circuit (kg)
	Rated power (Hp)	Rated power (kW)	
51	5	15	0,8
71	6,5	19	0,8
71	6,5	19	0,9
81	7,5	25	1,2
101	10	30	1,6
151	15	45	1,9

Contents of pressurization refrigerant

Discharge pipe and liquid pipe:

	Weight in kg per metre of pipe (R407C)							
Diameters	**Ø 10/12**	**Ø 12/14**	**Ø 14/16**	**Ø 16/18**	**Ø 20/22**	**Ø 26/28**	**Ø 33/35**	**Ø 39/42**
Liquid pipe	0,08	0,11	0,15	0,20	0,31	0,53	0,94	1,31
Discharge pipe	0,02	0,03	0,05	0,06	0,09	0,16	0,26	0,36

Weight of refrigerant in pipes

Air-cooled condensers with CEA axial fans:

Model	Contents of refrigerant circuit (kg)	Model	Contents of refrigerant circuit (kg)
CEA 21c H/V	0,66	**CEA 91c H/V**	3,8
CEA 21c/LN H/V	1,0	**CEA 101c H/V**	5,2
CEA 31c H/V	1,32	**CEA 101c/LN H/V**	4,0
CEA 31c/LN H/V	2,0	**CEA 111c H/V**	5,3
CEA 41c H/V	1,32	**CEA 111c/LN H/V**	6,0
CEA 41c/LN H/V	1,9	**CEA 121c H/V**	4,0
CEA 51c H/V	1,95	**CEA 121c/LN H/V**	7,3
CEA 51c/LN H/V	2,9	**CEA 131c H/V**	4,0
CEA 61c H/V	2,58	**CEA 131c/LN H/V**	8,0
CEA 71c H/V	1,89	**CEA 151c H/V**	6,0
CEA 71c/LN H/V	3,6	**CEA 181c H/V**	8,0
CEA 81c H/V	2,88	**CEA 181c/LN H/V**	8,0
CEA 81c/LN H/V	4,0	**CEA 201c H/V**	10,5

Refrigerant contents of the circuit

The sum of the refrigerant contents (air conditioner + liqid pipe + discharge pipe + condenser) gives the total refrigerant charge required by the system:

Refrigerant contents of air conditioner OHA 51H:	0,8
Refrigerant contents of condenser CEA 61:	2,6
10 metres of 16/18 diameter discharge pipe = 0.06 kg/m x 10 =	0,6
10 metres of 10/12 diameter liquid pipe = 0.08 kg/m x 10 =	0,8
Total refrigerant content:	**4,8**

Obviously machines with two refrigerant circuits (e.g. models 202), the charge for each circuit is to be calculated in the same way as model 101 machines.

It is also necessary to add oil to the circuit in a quantity equal to approximately 5% of the total amount of refrigerant in the circuit. We recommend the use of SUNISO 3 GS for machines charged with R22 and MOBIL EAL ARTIC 22 BC or equivalent polyesters for machines charged with R407C.

4.6 ELECTRICAL CONNECTIONS

WARNING!
BEFORE CARRYING OUT ANY OPERATIONS ON THE UNIT, SET THE MAIN SWITCH TO POSITION "O"

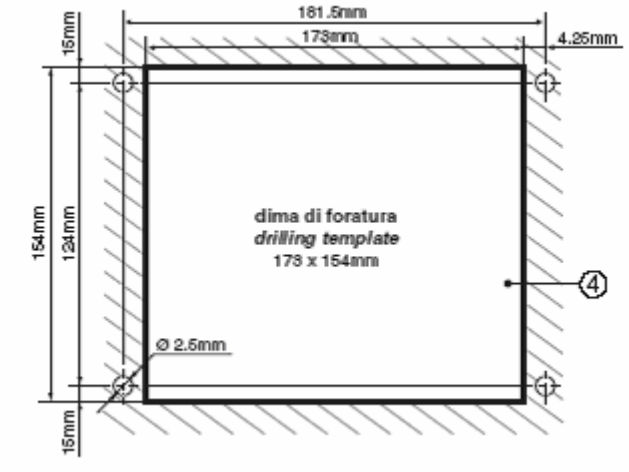
The external electrical connections of the air conditioner must satisfy the following preseciptions:

- They must be suitably dimensioned to withstand the maximum load in Amperes indicated on the electrical wiring diagram and on the data plate located inside the electrical compartment of the unit itself.
- The power supply must be within the following limits in order to avoid possible malfunction of the installed components:
  - Voltage tolerance limits: ± 10%
  - Frequency tolerance limits: ± 2%
- The power supply line from the external RCBO (Residual Current Breaker with Overcurrent protection) to the machine must be direct without any interruptions or junctions.
- The thermal-magnetic circuit breaker, the installation of which is responsibility of the Customer, is essential in order to provide overcurrent protection on the supply line (Articles 7.2.1 and 7.2.6 of standard CEI EN 60204-1), and must be located as near as possible to the machine. The thermal magnetic circuit breaker must be equipped with a residual current device (RCD) with a trip settings of 30 - 300 mA to provide protection for persons against both indirect and direct contact, in addition to thermal and magnetic overload protection. The RCD serves also to protect the air conditioner against insulation failure.
- The earth connection must be made with a conductor having the minimum cross-section indicated in the wiring diagram.
- To prevent operating problems with the microprocessor controls, it is necessary that no other loads (pumps, condensers, etc.), even those that are part of the same system, are connected downstream of the main switch of the air conditioner, unless explicit permission is granted by TECNAIR LV. If this condition cannot be met, it will be necessary to connect suppressors (R + C) in parallel with the coils of the relays of any such loads.
- The signal/control cables must be kept separate from high-current cables, power cables and any cables that are potential sources of electromagnetic interference.
- To avoid possible damage to electrical and electronic equipment, particularly in outdoor units, caused by voltage surges in the electrical supply line, TECNAIR LV recommends evaluating the necessity of installing SPDs (Surge Protection Device) appropriately rated for the type of installation and the frequency of direct lightning strikes on the electrical supply line.

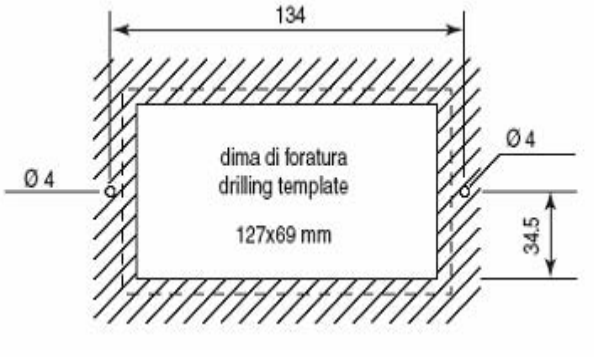
4.6.1 INSTALLATION OF THE REMOTE CONTROL INTERFACE

If the complete terminal or reduced version is to be panel or recess mounted, the maximum thickness of the panel must be 6 mm; if the terminal is to recessed mounted in a wall, a masonry box with internal dimensions sufficient to accommodate the terminal and the connection cables must be provided.

The drilling templates are illustrated below:



Complete terminal

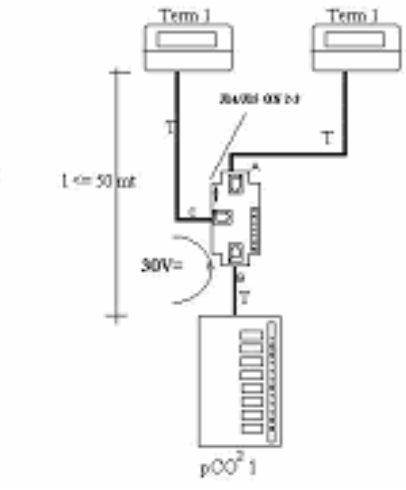


Reduced terminal

The user terminal is to be conected to the main board via a 6-wire telephone cable. To make the connection, it is sufficient to plug one of the telephone connectors into one of the terminals of the TCON6 board and the other into the terminal connector, as shown in the wiring diagram.

For safe connection, use the toroid supplied with the user terminal to avoid interference on the line could damage the memory or components of the board itself.

If the terminal is disconnected from the board when the unit is powered on, we recommend waiting at least 5 seconds before reconnecting it.



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Connection of user terminals

4.6.2 INSTALLATION OF THE TEMPERATURE/HUMIDITY SENSOR SUPPLIED WITH THE UNIT

There are two types of sensor supplied with the unit (accessories):

1) Temperature sensor or temperature/humidity sensor for duct installation:

   - Temperature sensor for the supply air duct: To be installed inside the supply air duct at the point nearest to the outlet vents. The humidity sensor is to be installed on board the machine in the return air compartment.

   - **Temperature and humidity sensor for the retun air duct** To be installed inside the return air duct at the point nearest to the return air inlet vents.

2) **Wall-mounted temperature sensor or temperature/humidity sensor:** To be installed in the room to be controlled at a height of approximately 1.7 m.

Take care during sterilization to protect the sensor to prevent damage to the electronic components!

4.6.3 INSTALLATION OF THE AMBIENT DIFFERENTIAL PRESSURE SWITCH

The differential pressure switch installed in the room to be controlled is of fundamental importance in that it continuously transmits the ambient pressure reading to the microprocessor control. It therefore enables the microprocessor control to take the actions necessary to maintain the correct positive or negative pressure in the room.

The pressure switch uses two aeraulic inputs and an electrical terminal block to be connected with a shielded 3x0.35 cable (AWG22) to the terminal block of the electrical panel, as shown in the wiring diagram.

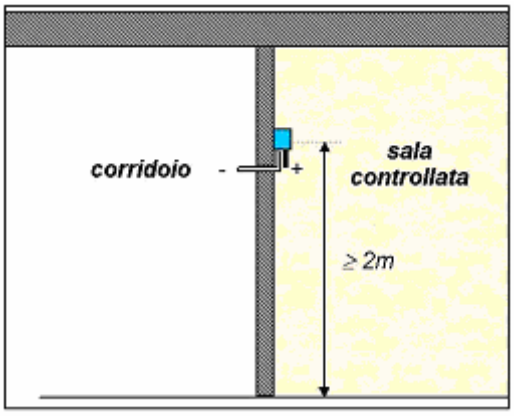
The connection cable is not supplied by TECNAIR LV.

The difference in pressure between the controlled room and the reference environment is measured via two flexible transparent pipes with diameter 4/7.

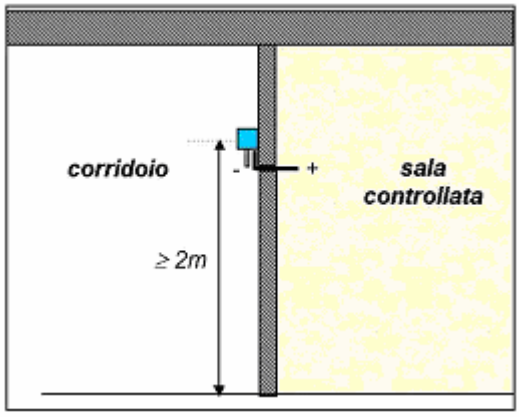
4.6.4 POSITIONING OF THE AMBIENT DIFFERENTIAL PRESSURE SWITCH

The pressure switch can be positioned in various ways. The following figures show the typical types of installation. Wherever you decide to install the pressure switch, the following points are essential

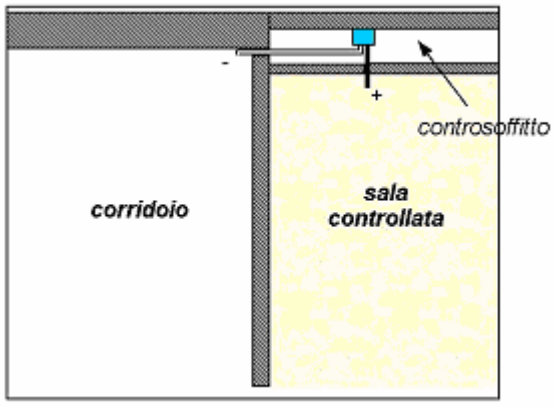
- Connect the pipe with the free end in the room to the positive socket of the differential pressue switch, **even in the case of negative room pressure,** protruding a few centimetres from the wall or ceiling**.**
- Ensure the pressure switch is at least 2 metrs from the floor level, so that it is better protected against dust deposits or possible impact.



Installing the differential pressue switch in the room



Installing the differential pressure switch in an environment adjacent to the room



Installing the differential pressure switch in the room

5 CHECKS AND FIRST STARTUP

WARNING!
BEFORE CARRYING OUT ANY OPERATIONS ON THE UNIT, SET THE MAIN SWITCH TO POSITION "O"

Before the Mnufacturer's personnel proceed with the testing and startup of the machines, the checks listed in the following form must be carried out.

DATE _____

PLACE _____

OPERATOR'S SIGNATURE _____

CUSTOMER'S SIGNATURE _____

Checks to be carried out before calling technician for startup

Machine startup with the refrigeration circuit requires that the units are powered on for at least two hours prior to the arrival of the technician in order to allow the compressor's crankcase oil heater to reach working temperature and allow evaporation of any refrigerant deposited in the compressor to ensure that the compressor/s function/s correctly. The crankcase heaters switch on automatically when the machine is powered on.

REFRIGERANT CIRCUIT CHECKS

	DESCRIPTION	POSITIVE	NEGATIVE
1	Check discharge pipe diameter conforms with indication in the installation manual.		
2	Check "horizontal" sections of the discharge line have a gradient of at least 1% in direction of refrigerant flow		
3	Check that siphons are installed at the lowest point of each rising pipe and every 3 m along rising pipe sections, as well as a counter siphon at the highest point of the rising pipe.		
4	Check the non-return valve is installed as near as possible to the compressor with the apertue in the direction of refrigerant flow (pipes longer than 5 m).		
5	Check the non-return valve is installed as near as possible to the compressor with the aperture in the direction of refrigerant flow (pipes longer than 10 m).		
6	Check that the discharge pipe is insulated in the sections where accidental operator contact is possible (pipe operating temperature approx. 70/80°C)		
7	Check that support brackets are installed on the discharge pipe every 3 m and are not too tight so as to allow expansion of the pipe.		

8	Check that the diameter of the liquid pipe conforms to requirements.		
9	Check that support brackets are installed every 3 m.		
10	Check that refrigerant circuit valves are open, including the valve on the hot gas injection pipe.		
11	Check the electrical connections to the condenser disconnect switch.		
12	Check that the disconnect switch is in the closed position (condenser powered on).		
13	Check the refrigerant pipe connections between the condenser and the evaporator are in the opposite direction to the air flow and the refrigerant flow.		
14	Check that the condenser is correctly popsitioned far away from walls and/or other condensers to avoid recirculating air currents that could impair its operation.		
15	Check the charge level in the refrigerant circuit.		
16	Check the evaporation pressure.		
17	Check the condensation pressure.		
18	Check the superheating of the refrigerant aspirated by the compressor.		
19	Check the subcooling of liquid refrigerant.		
20	Check that the liquid line filter is not clogged.		
21	Check the power consumption of the compressor.		
22	Check operation of the high pressure control switch.		
23	Check operation of the low pressure control switch.		
24	Check the compressor operating temperature.		

WATER CIRCUIT CHECKS

	DESCRIPTION	POSITIVE	NEGATIVE
25	Check that the inlet and outlet of the hot and cold water supplies conform with the arrows marked on the fittings or, if these are missing, with the drawings in the installation manual of the machine.		
26	Check that all the liquid supply pipes are provided with manual shut-off cocks just outside to the machine, and that theses cocks are open.		
27	Check that the condensate drain outlet does not have taps or restrictions.		
28	Check that the hardness of the water supply is between 10 and 40 French degrees.		
29	Check that the humidifier supply fitting is connected to the mains drinking water supply and that it is provided with a manual shut-off valve just outside the machine.		

ELECTRICAL POWER SUPPLY CHECKS

	DESCRIPTION	POSITIVE	NEGATIVE
30	Check the connetion of the three phases, neutral and earth.		
31	Check that the power supply voltage and frequency are within the tolerance limits of +/- 10%.		

CHECKS FOR AMBIENT SENSOR AND REMOTE TERMINAL CONNECTIONS (IF PRESENT)

	DESCRIPTION	POSITIVE	NEGATIVE
32	Check positioning as prescribed in the installation manual.		
33	Check that electrical connection between the sensors and the electrical panel is as indicated in the wiring diagram and the installation manual.		
34	Check the installation and connection of the ambient pressure switch is as indicated in the wiring diagram and installation manual.		

NOTES ON ANOMALIES ENCOUNTERED DURING CHECKS

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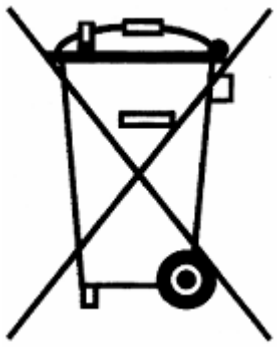
6 DEACTIVATION, DISASSEMBLY AND SCRAPPING

WARNING!
BEFORE CARRYING OUT ANY OPERATIONS ON THE UNIT, SET THE MAIN SWITCH TO POSITION "O"

TECNAIR LV air conditioners must only be dismantled by specialised technical personnel. In any case, the following points must be observed:

- Switch off the air conditioner first by way of the microprocessor control
- Open the machine's main door lock switch
- Open the external thermal-magnetic circuit breaker to isolate the air conditioner from the electrical power supply
- The refrigerant contained in the air conditioner should be disposed of in accordance with the waste disposal and safety regulations applicable in the country of installation.
- Disconnect, where applicable, the refrigerant lines, the water connections and the condensate drain lines from the air conditioner.
- The scrapping of air conditioner is subject to the prevailing legal requirements in the country of installation.
- TECNAIR LV recommends that you contact an authorised waste disposal contractor for this purpose.
- Air conditioners are made primarily from raw materials such as aluminium, copper and steel.

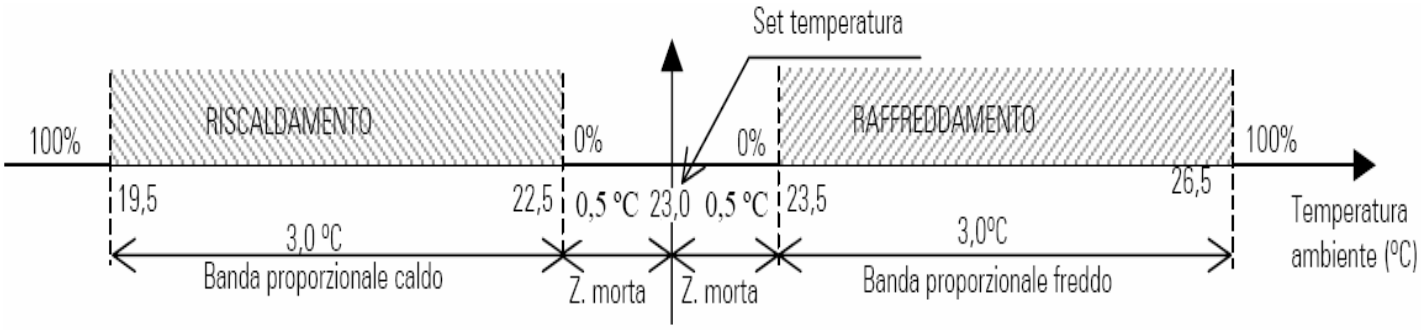


7 USE OF THE AIR CONDITIONING UNIT

7.1 TEMPERATURE CONTROL

The heating and cooling devices are controlled in accordance with the temperature readings measured by the ambient sensor (or return air sensor) This temperature reading is compared with the set-point temperature, and the heating and cooling devices are activated according to the difference between these temperature values. The proportional band determines the operating range of the air conditioner and may assume different values during heating and cooling. The dead band identifies a range around set-point in which no control action takes place.

The following diagrams illustrate the behaviour of the heating and cooling devices. The percentage values indicate the degree to which the modulating valves are opened.



7.1.1 PROPORTIONAL CONTROL

Acts on the response speed of the system; increasing this value decreases operating error to one step, but makes the system less stable (leads to over-sensitivity of the control system);

The control action is a function of the difference between the desired temperature or humidity value (set-point) and the value actually measured expressed as a percentage of the proportional band.

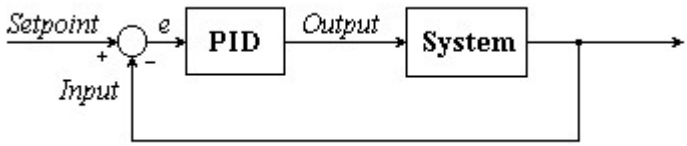
7.1.2 PROPORTIONAL + INTEGRAL CONTROL

The control action is a function of the percentage difference on the poportional band between the desired temperature and the calculated average temperature in the “integration time”.

In this way the control operates on the basis of an historical archive of the values assumed by the temperature during the integration time and not just on the basis of the instantaneous temperature value. This eliminates the effect of any sudden and temporary changes in the temperature.

7.1.3 PROPORTIONAL + INTEGRAL + DERIVATIVE CONTROL

Increases system damping and stability, thus enhances the other two control actions (with their respective benefits) while maintaining stability. The control action is effected in accordance with the function:

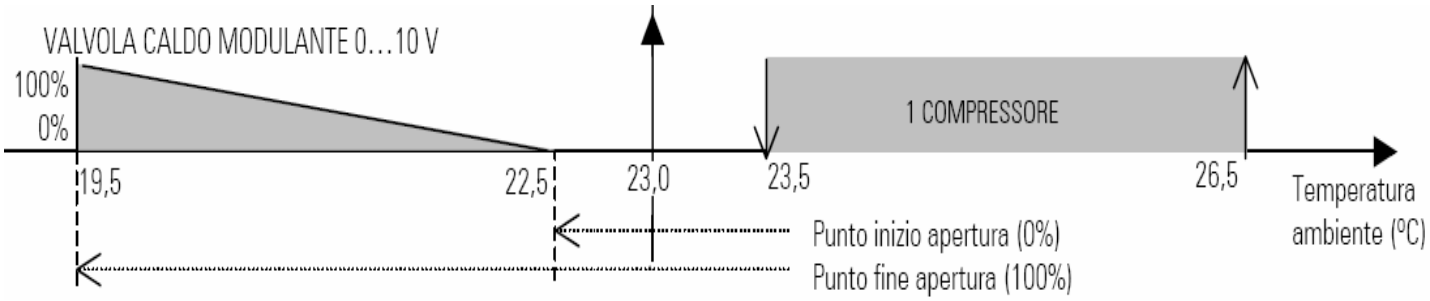


$$Output = Kp * (e + \frac{1}{Ti} * \int e \cdot dt + Td \frac{de}{dt})$$

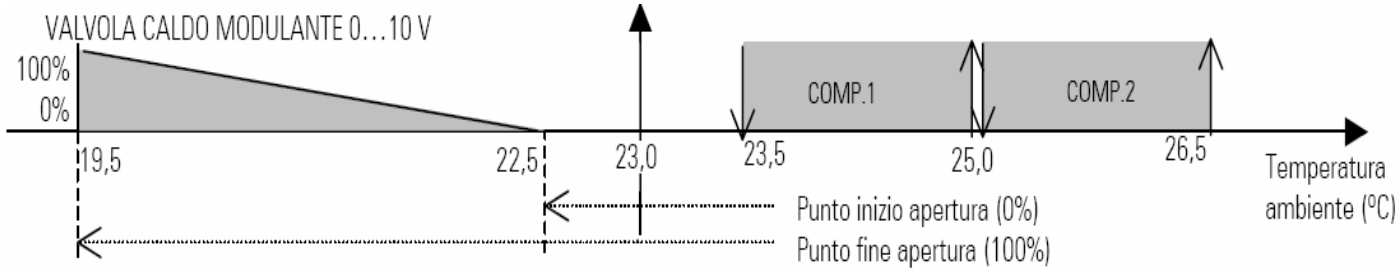
where ***Kp*** represents the proprotional band, ***e*** represents the error ***(Input - Setpoint)***, i.e. the difference between the actual value and the set-point value, ***Ti*** and ***Td*** are respectively the derivation and integration times, from the time interval taken into consideration and the error interval. We advise that initially only Proportional Control is used, adjusting the ***Kp*** value until satisfactory operation is obtained; at this point integral control action ***Ti*** may be introduced, while simulatenously reducing the ***Kp*** so as not to impair system stability. Finally, on introducing derivative control action ***Td***, the system tends to stabilise and it will therefore be possible to increase the ***Kp*** again.

7.1.4 SERIES H DIRECT EXPANSION AIR CONDITIONERS

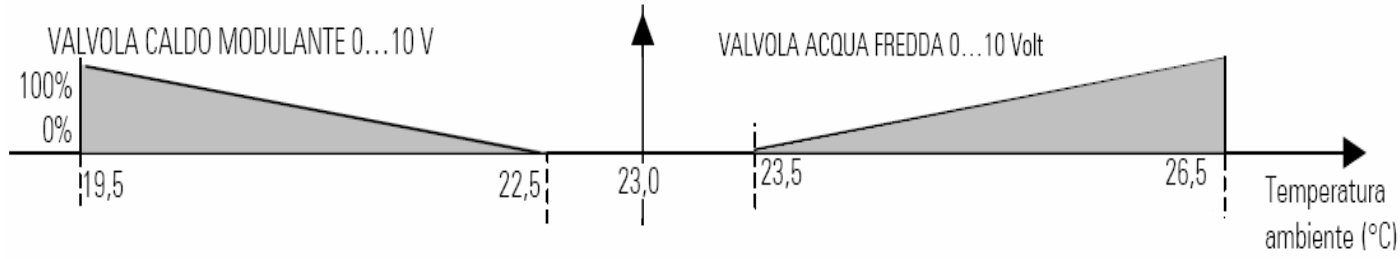
- **AIR CONDITIONER WITH A SINGLE COMPRESSOR**



- **AIR CONDITIONER WITH TWO COMPRESSORS**



7.1.5 CHILLED WATER AIR CONDITIONER



7.1.6 COOLING CAPACITY CONTROL WITH HOT GAS INJECTION VALVE

Control of cooling capacity is achieved through an electronic hot gas injection system. Injection of hot gas downstream of the thermostatic valve reduces cooling capacity in proportion to the request from the control system.

With this system it is possible to modulate the cooling cpacity between 50% and 100% of the rated capacity, and obtain a corresponding reduction in power consumption. The opening of the injection valve is controlled by a 0 to 10V signal directly proportional to the percentage difference of the temperature from the set-point in relation to the proportional band.

7.1.7 COOLING CAPACITY CONTROL WITH HOT GAS INJECTION VALVE AND ELECTRONIC EXPANSION VALVE

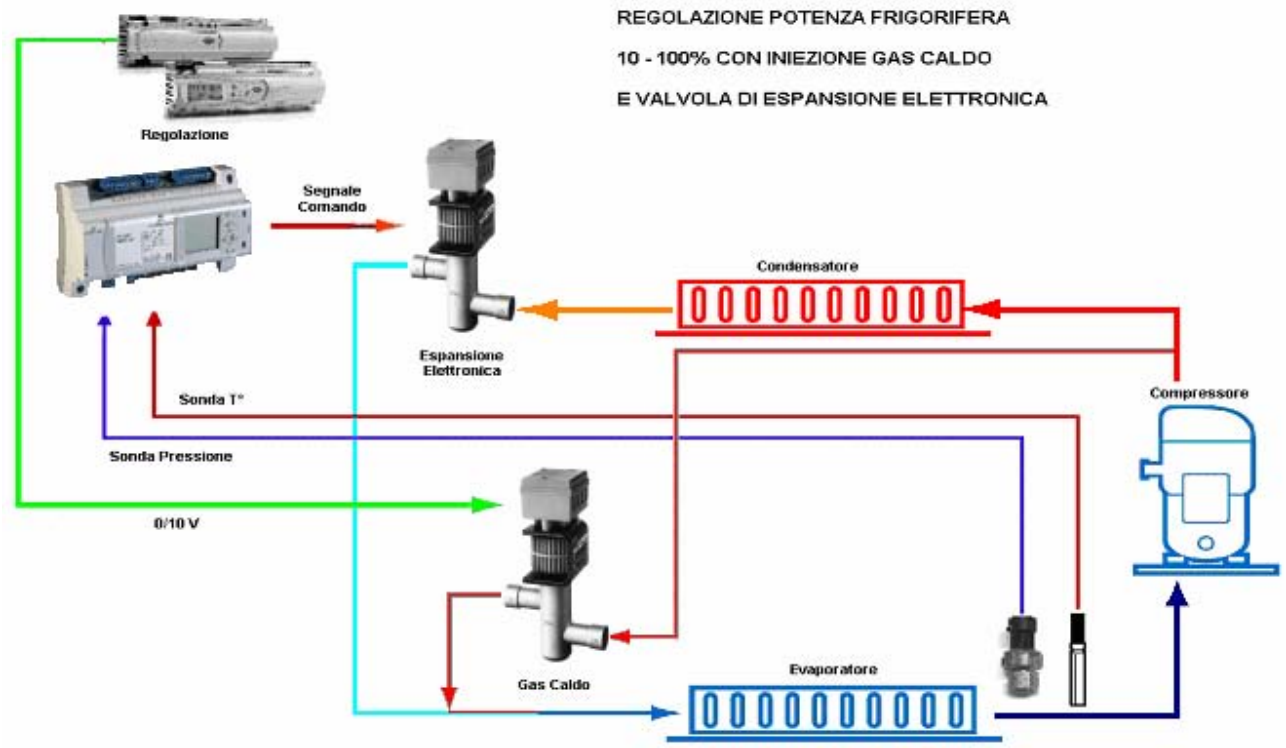
In cases where a 50% reduction in cooling capacity is not compatible with the requirement for perfect system control, installation of an electronic expansion valve in place of the standard thermostatic expansion valve allows electronic control of the hot gas to reduce cooling cacpity down to just 10% of the system's rated capacity.

The electronic expansion valve (EEV) allows control of superheating on the suction line for more efficient and versatile operation of the refrigeration system.

Efficient, because the optimisation and stabilization of the flow of refrigerant to the evaporator increases the overall output of the system while at the same time guaranteeing safety (less frequent tripping of the low pressure control switch, less liquid refrigerant returning to the compressor, ...). Furthermore, if the EEV is correctly dimensioned, the use of the floating condensation (and evaporation) pressure or at low set-point significantly increases system efficiency, ensuring reduced power consumption and greater cooling output.

Versatile, because the EEV affords the possibility to serve refrigeration units of different cooling capacities in widely differing operating conditions.

The following diagram shows a typical system layout. The priorities to be considered for optimal control of the refrigeration system are a high and constant cooling capacity as well as an equally low and stable superheating.



7.2 HUMIDITY CONTROL

Humidification control action is effected proportionally through the use of the following components:

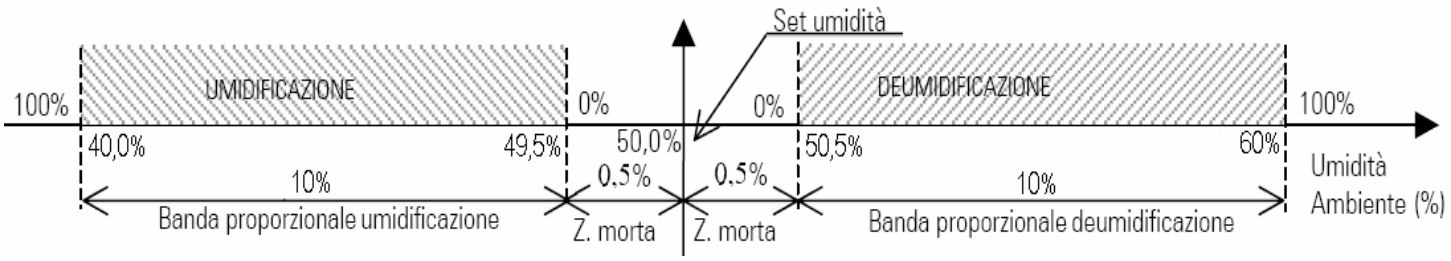
- Integrated immersed electrode humidifier
- External humidifier (not supplied by TECNAIR LV)

Proportional control provides a modulating effect on the quantity of steam produced, which in the case of the integrated humidifier ranges from to 8 to 100% of the total production, for both types of microprocessor control.

Dehumidification control is effected by a startup/opening step of the cold component with activation at the limit of the proportional control band. Once the component has been activated, the control proceeds by regulating the cooling capacity, in the case of the hot gas bypass or water chilled coil, up to the set-point.

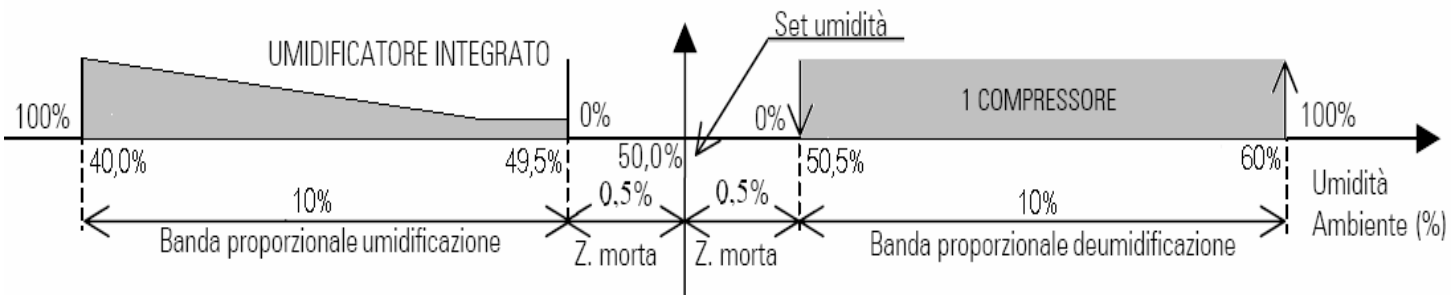
The cooling capacity is never reduced below 60% of the total to allow the effect of dehumidification.

The figure illustrates the system described above:

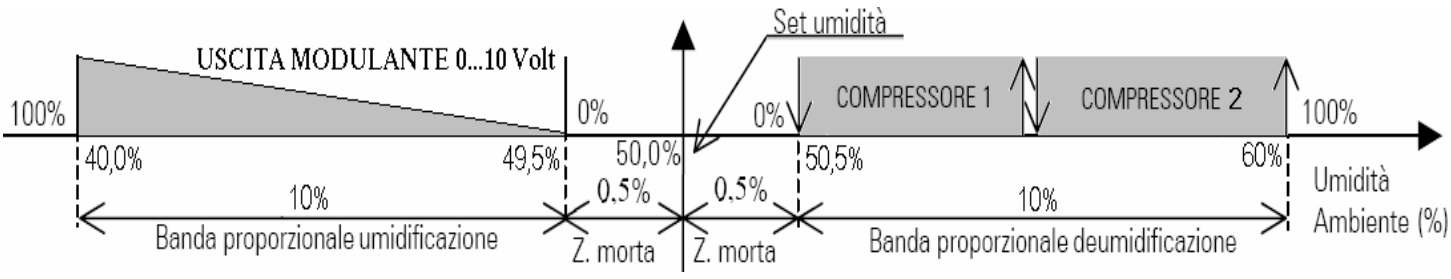


7.2.1 SERIES H DIRECT EXPANSION AIR CONDITIONERS

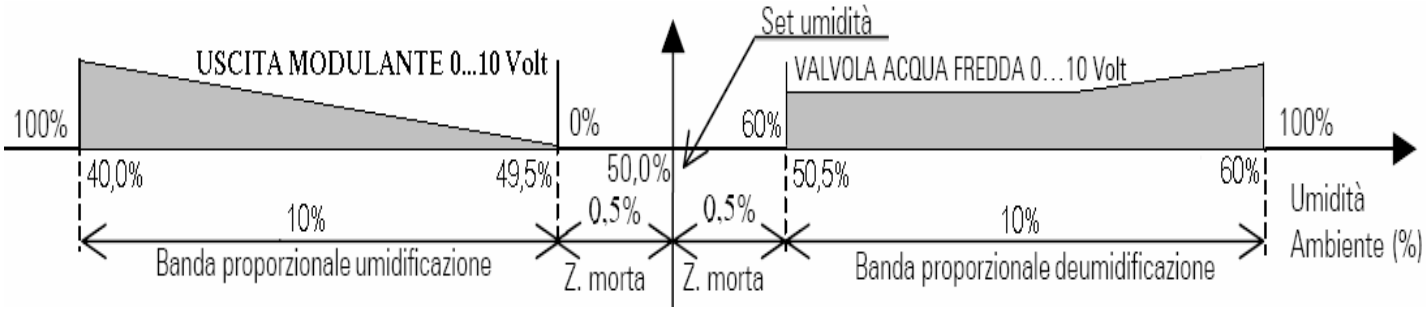
- **AIR CONDITIONER WITH A SINGLE COMPRESSOR**



- **AIR CONDITIONER WITH TWO COMPRESSORS**



7.2.2 CHILLED WATER AIR CONDITIONER



7.2.3 SIMULTANEOUS HUMIDIFICATION AND COOLING

Cooling the air increases its relative humidity until it reaches saturation point. It is clear that the air's capacity to absorb vapour depends on its relative humidity and falls to zero near saturation point. Attempting to humidify air in these conditions, i.e. immediately after cooling, cause the vapour to condense and the consequent formation of puddles of water inside the machine, and significant energy wastage.

For this reason, series H units are equipped with devices to interrupt humdification during operation:

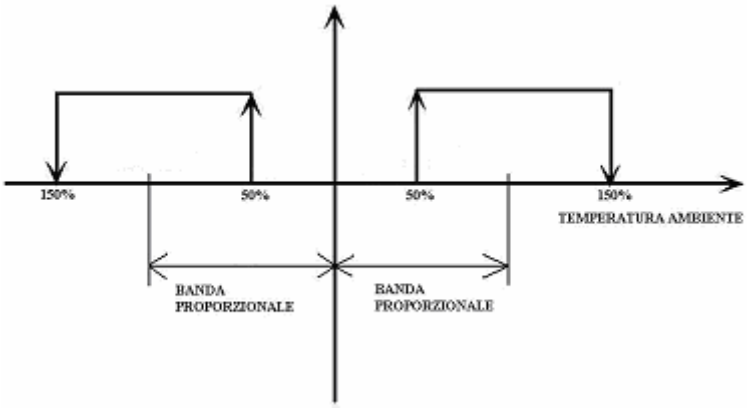
- **Compressurized units:** humidification is disabled by the specific parameter.
- **Chilled water unit:** humidification is enabled by the specific parameter.

Should it be necessary to humidify the air at the same time as cooling it, we recommend installing an external room humidifier.

7.2.4 DEHUMIDIFICATION LOCK

In cases where a post-heating coil (accessory) is not installed, problems of low temperature supply air may occur during dehumidification. In this case, a software lock intervenes to prevent a significant drop in room temperature.

If the air conditioner is dehumidifying and the temperature exceeds 150% of the proportional band, the microprocessor will inhibit dehumidification, thereby giving priority to temperature control. Dehumidification may restart, if still required, when the temperature reaches 50% of the proportional band.



7.3 SPECIFIC FUNCTIONS OF THE CONTROL SOFTWARE

This chapter describes certain specific functions of the control software for the series H unit.

For more detailed descriptions of the components and accessories involved in the processes, pleae refer to the installation manual supplied with the unit.

7.3.1 NIGHT-TIME STAND-BY

This function, which is activated from the specific screen page, enables the unit to operate at reduced level during the hours in which the room is not in use, thereby allowing energy savings.

Stand-by can be activated by daily time bands, by setting start and end times, by digital input and by remote supervisor.

In the event of an emergency, the stand-by can be deactivated at any time to restore normal operation of the unit.

During night-time stand-by, the unit is controlled using the folowing parameters:

TEMPERATURE CONTROL	Effected through two set-points, one high and one low, that afford a wide window of inactivity while maintaining the room conditions within the minimum and maximum values.
HUMIDITY CONTROL	Effected in the same way as temperature control.
AIR FLOW RATE AND AMBIENT PRESSURE CONTROL	Both are reduced to the minimum values that can be set.
PRESSURE CONTROL IN SUPPLY AND RETURN AIR DUCTS	Controlled in the same way as air flow rate
TEMPERATURE/HUMIDITY ALARM CONTROL	Effected through thresholds linked to the various set-points described above.

7.3.2 UPS CONNECTION

If the unit is connected to a UPS system via the specific digital input (see wiring diagram), it will be possible to reduce the electrical power consumption of the unit to the minimum while still guaranteeing the sterility of the air in the room.

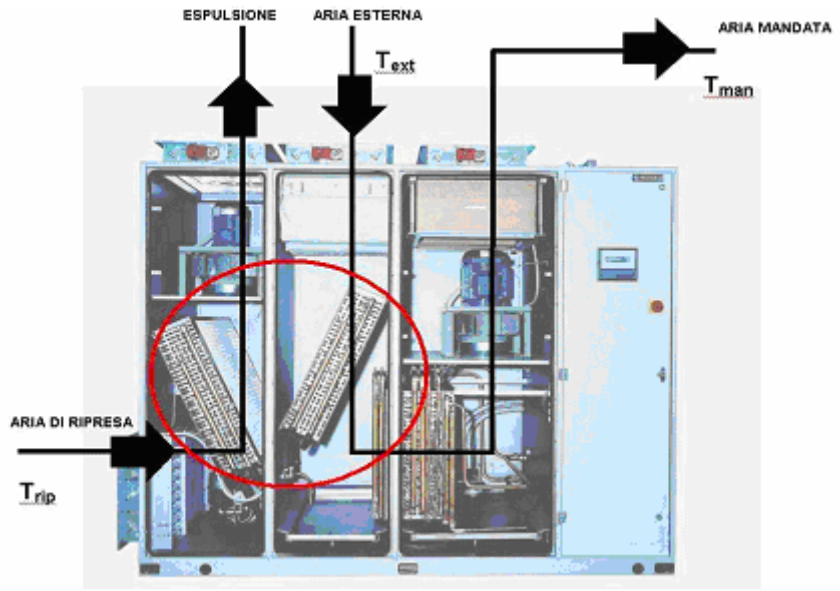
During operation powered by a UPS, components with high power consumption will be disabled.

- **COMPRESSORS**
- **IMMERSED ELECTRODE HUMIDIFIER**
- **ELECTRICAL HEATING AND POST-HEATING COILS**

All components not included in this list will continue to function normally.

7.3.3 "H – HR" HEAT RECOVERY SYSTEMS

The heat recovery system is based on the exchange of heat between external air and the air returned from the conditioned room. The transfer of heat between the two coils (shown in figure within the red circle) occurs via a specific pump and an expansion valve that uses water as the heat exchange medium.



The system either adds or removes heat to/from the air entering the machine, in accordance with the preset temperature regime.

The operation of the heat recovery system depends on the temperature values:

- **T_{ext}** = external air temperature
- **T_{rip}** = return air temperature

SUMMER OPERATION: If the condition $T_{ext} - T_{rip} > \Delta T$ is met, where ΔT is a parameter that can be set via sotware configuration between 1°C and 5°C, and the water pump is in operation, the externa; air entering the machine is cooled free of charge.

WINTER OPERATION: If the condition $T_{ext} - T_{rip} < \Delta T$ is met and the water pump is in operation, the external air entering the machine is heated free of charge.

7.3.4 SUPPLY TEMPERATURE CONTROL (LIMIT)

The control of high and low supply temeparure is effected by way of various types of control in accordance with system requirements.

High temperature can be controlled in the following ways:

- **ALARM ONLY:** after the time delay, an alarm is generated
- **STOP HOT:** when the alarm threshold is exceeded, the hot component is deactivated; if, after the time delay, the temperature has still not fallen below the threshold, an alarm is generated.
- **HOT + COLD:** when the alarm threshold is exceeded, the cold component is activated proportionally to maintain the temperature below the alarm theshold. If after the time delay the temperature has still not fallen below the threshold, an alarm is generated.

Low temperature can be controlled in the following ways:

- **ALARM ONLY:** after the time delay, an alarm is generated
- **COLD STOP:** when the alarm threshold is exceeded, the cold component is deactivated; if, after the time delay, the temperature has still not risen above the threshold, an alarm is generated.
- **HOT + COLD:** when the temperature exceeds the alarm threshold, the cold component is activated proportionally to maintain the temperature below the alarm theshold. If after the time delay the temperature has still not fallen below the threshold, an alarm is generated.
- **HOT + COLD:** when the temperature exceeds the alarm threshold, the hot component is activated proportionally to maintain the temperature above the alarm theshold. If after the time delay the temperature has still not risen above the threshold, an alarm is generated.

7.3.5 ANTIFREEZE SYSTEM

This system, enabled only when the relative temperature sensor and heating coil are installed, affords active protection against freezing and can be operated with two different management strategies:

DAYTIME: if the antifreeze sensor, during normal operation, detects a temperature below the programmable setpoint, the system activates the heating:

- If after reaching 1000% the temperature is still below the alarm threshold, the fans will be switched off and a message will appear on the main screen page. The moment the temperature rises above the programmed threshold, the fans will be switched on again.
- If the problem recurs more than 3 times in one hour or if the temperature remains below the alarm threshold with the fans off for more than 10 minutes, a major alarm message will be displayed and the unit will be shut down.

NIGHT-TIME: if the unit is tunred OFF at night, an additional protection system acts as above, opening the hot valve so that the water circulates in the coil and thus prevent freezing.

THIS SYSTEM CAN ONLY ACTIVATED ON UNITS WITH CHILLED WATER COILS!

7.3.6 STERILIZATION CYCLE

This function, which can be activated from the relative menu, serves to disinfect the room, the air ducts and the unit itself through the introduction of a sterilizing gas such as Glutaraldeide.

The operating cycle is comprised of three stages:

1) **DISTRIBUTION OF THE STERILIZING AGENT:** the unit stops the exhaust fan, closing the relative damper, and fully opens the recirculation damper. In this way the sterilizing agent reaches and saturates all components of the aeraulic circuit. (Default 1 hour)

2) **UNIT SHUTDOWN:** in this stage the unit is shut down completely so as to allow the sterilizing agent to work. (Default 1 hour)

3) **WASHING:** the unit activates both fans at 100% and shuts completely the recirculation damper. This introduces large quantities of clean air expels all traces of the sterlizing agent. (Default 1 hour)

4) **CYCLE END:** the sterilization cycle is terminated and the unit resumes normal operation.

THE CYCLE CAN ONLY BE ACTIVATED IF THE RECIRCULATION DAMPER IS INSTALLED

7.3.7 EMERGENCY OPERATION WITH UNIT IN NEGATIVE PRESSURE

This emergency procedure can be activated by holding pressed the red EMERGENCY button.
During the emergency period, the unit will work with a negative ambient pressure set-point so as to ensure that potential contaminants are not released into the controlled environment.

The set-point, which is set automatically by the software and cannot be modified, is -15 Pa.

Once the emergency period is over, normal operating conditions can be restored by holding pressed the blue NORMAL key.

NOTE: The state of emergency will be activated only in the case of operation with positive ambient pressure control (OVER-PRESSURE).
The negative pressure value obtainable will depend on the controlled environment.

8 ROUTINE AND MAJOR MAINTENANCE

WARNING!
BEFORE CARRYING OUT ANY OPERATIONS ON THE UNIT, SET THE MAIN SWITCH TO POSITION "O"

8.1 PROGRAMMED MAINTENANCE CHART

The recommended unit maintenance programme is summarised in the following chart:

COMPONENTS		CHECK EVERY			
		1 MONTH	3 MONTHS	6 MONTHS	1 YEAR
FANS	Check general condition: corrosion, mountings, cleanliness		X		
	Check motor noise		X		
	Check the rotor: vibration, imbalance		X		
	Check power consumption			X	
	Clean the rotor and the motor		X		
AIR FILTERS	Check the condition of the filters: Mountings, signs of damage	X			
	Check filters are not clogged	X			
	Check operation and calibration of differential pressure switches			X	
MICROPROCESSOR CONTROL	Check the system operates correctly	X			
	Check the display LEDs and the alarm status		X		
	Check the mother board connections			X	
	Check the control and display boards			X	
	Check that the unit's sensor readings are correct			X	
INTERNAL HUMIDIFIER	Check the condition of the cylinder	X			
	Carry out the automatic cylinder washing pocedure	X			
	Check the condition of the filling and drain valves		X		
	Carry out manual washing with limescale preventer		X		
	Inspect the gaskets/seals		X		
	Renew if necessary		X		

MAINS STEAM VALVE	Check the condition of the valve		X		
	Check that the valve opens and closes correctly		X		
	Check the condensate drain		X		
	Check the operating pressures		X		
	Check operation of the maximum humidistat		X		
ELECTRICAL PANEL	Check the unit is receiving power correctly			X	
	Check the electrical connections			X	
	Check the power consumptions of electrical components			X	
	Test safety devices			X	
	Renew protection fuses				X
WATER CIRCUITS	Check circuits for leaks			X	
	Bleed air from circuits			X	
	Check circuit temperatures and pressures			X	
	Check operation of the 3-way valve		X		
	Check the quantity of glycol in the circuit			X	
	Check the water circulates correctly			X	
REFRIGERANT CIRCUITS	Check the operating temperatures and pressures			X	
	Check the condition of the compressor		X		
	Check the condition of the liquid sightglass filter			X	
	Check operation of the safety devices			X	
	Check the calibration and operation of the control valves		X		
	Check the refrigerant charge level and for circuit leaks		X		
	Check the lubricating oil level		X		
CONDENSERS	Check the condition of the remote condenser		X		
	Check the calibration of the remote condenser regulator		X		
	Check that the remote condenser is receiving power correctly			X	
	Check the pressure contolled valve of the water cooled condenser		X		
	Check the condenser water circulates correctly		X		

8.2 MAINTENANCE OF THE FANS

Fan maintenance operations must be carried out in conditions of maximum safety and always with the unit switched off.

During maintenance, check the following:

- Periodically check that the fan blades are clean and remove all dirt and encrusted deposits that could affect the balance of the rotor and thus damage the bearings.
- Check that the cooling fins of the fan motors are clean. If the fans produce any unusual noises during operation, switch off the machine and identifty and rectify the problem, renewing the fan or the motor if necessary.

8.3 REFRIGERATION CIRCUIT CHECKS

The refrigeration circuit does not require maintenance other than the periodic checks indicated the chapter “Start up”.

The first of these checks is to look for leaks, as indicated by the the presence of small bubbbles visible in the liquid viewed through the sight glass.

The cooling coil must be inspected and, if necessary, cleaned with hot soapy water using a brush with long soft bristles. Compressed air may also be used providing that it is free of oil.

8.4 MAINTENANCE OF THE ELECTRICAL BATTERY

It is sufficient to check that the battery is clean and that the power consumption in Amps is as specified in the technical data sheet. If the machine is equipped with a modulating electrical batttery, it is advisable to also check occasionally that the modulator is functioning correctly.

To do this, it is sufficient to check that the machine behaves correctly during heating operation, with the relative screen page showing a voltage of 0-10 V for the microprocessor output to the modulator. (See User manual).

8.5 MAINTENANCE OF THE ELECTRICAL PANEL

Maintenance of the electrical panel must be carried out every two months as follows:

- Electrical and electronic components: Clean using a compressed air jet at a minimum distance of 30 cm (to avoid danging plastic parts), pay particular attention to cooling fans and heat sinks.
- Air inlets: The air inlets are equipped with filters that afford protection to IP54. These filter must be cleaned or, if this is not possible, renewed.

WARNING!

Failure to clean and/or renew the air inlet filters will result in loss of IP54 protection.
TECNAIR LV shall not be liable for any damage resulting from a lack of correct maintenance of these filters.

8.6 MAINTENANCE OF THE AIR FILTERS

On TECNAIR LV air conditioners, all air filters are equipped with differential pressure switches to monitor pressure loss caused by clogging. The microprocessor signals when the measured pressure difference exceeds the set value. To change the trip setting of a differential pressure switch, simply unscrew the cover and turn the setting dial to the desired pressure differential value.

FILTER TYPE	POSITION	VALUE [Pa]
F5 filter	Air return	250
F6 filter	External air	300
F9 filter	Supply air	400

The filters must be renewed every time the relative clogged filter alarm is generated. To change a filter, switch off the unit, open the front panels and remove the filter. The panels to be opened are exclusively those indicated in the drawing supplied with the machine. They are to be opened using the key provided.

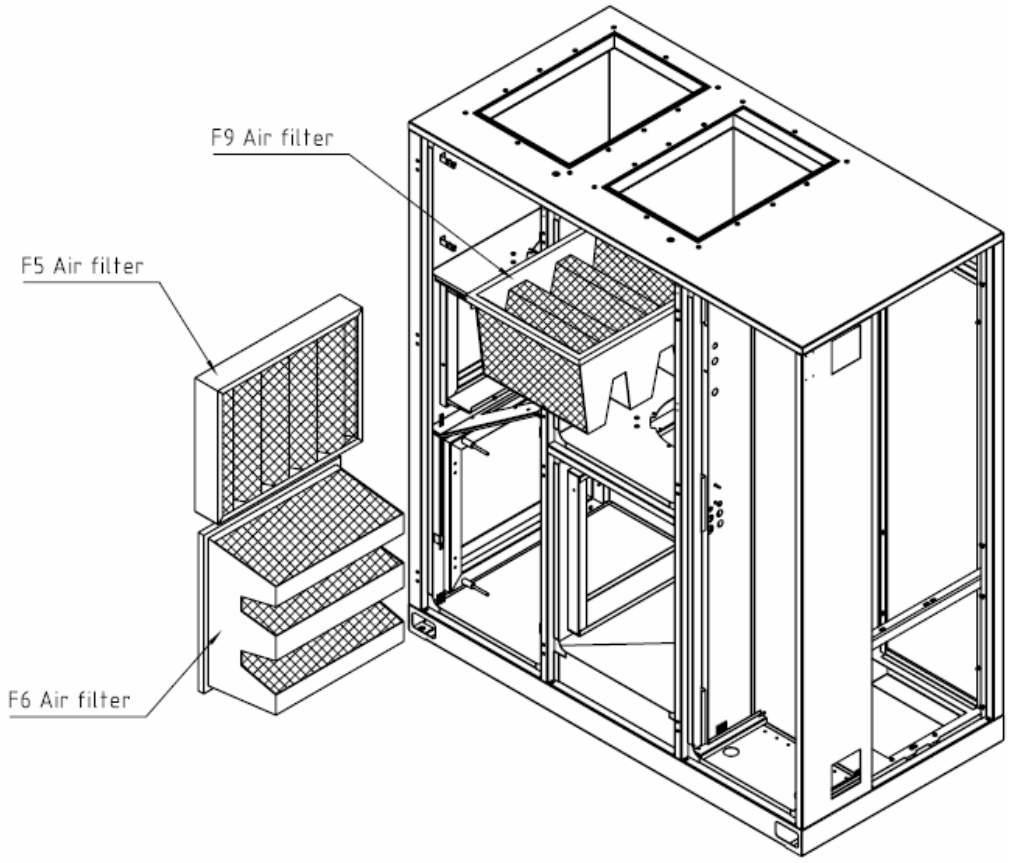
WARNING!

Used filters are to be disposed of as SPECIAL WASTE.

Under no circumstances may the air conditioners be operated without the filters.

To ensure the efficiency of the filters, it is necessary to install the 15x3 mm seal.

We also recommend installation of an external air pre-filtration system with an efficiency of at least G3 to avoid frequent clogging of the F6 filters and thus reduce the system operating costs.



9 WASHING, CLEANING AND DISINFECTION

WARNING!
BEFORE CARRYING OUT ANY OPERATIONS ON THE UNIT, SET THE MAIN SWITCH TO POSITION "O"

9.1 WARNINGS

1) Before proceeding with any cleaning operations, it is essential to read the following information and make sure that you have fully understood it.

2) All cleaning operations must be carried out in accordance with the instructions given here below, as incorrect procedures could be seriously damage the equipment and/or be hazardous for the operator.

3) TECNAIR LV air conditioners contain rotating parts, live parts and pressurised parts. To avoid all risks, before opening the unit for any cleaning operations, it is essential to proceed as follows:

   - Make sure that the unit has been switched off.
   - Make sure that all moving parts (compressor in the drive compartment, exhaust fan and supply fan) are stationary (i.e. have have stopped rotating).
   - Make sure all electrical power supply lines to the appliance are disconnected.

4) The following instructions apply exclusively to the cleaning of the air conditioner. It is assumed that the maintenance, cleaning and/or disinfection of system components (inside the air ducts, air vents and/or diffusers, germicidal lamps, humidifier water supply treatment systems, condensate drainage systems, ect.) are carried out at the intervals and in the manner indicated by the respective manufacturers and by the system installer.

5) The cleaning, washing and disinfection of the air conditioner alone, even when carried out in accordance with the instructions given in this manual, are not in themselves sufficient to ensure the necessary aseptic conditions in the entire system TECNAIR LV series "H" air conditioners, although equipped with internal filters, are designed for climate control, not to ensure the sterility of the environment. To guarantee the necessary degree of environmental sterility, the installer must install under their own responsibility and at their own expense absolute filters at each air vent or diffuser in the room.

6) The cleaning of the series "H" air conditioners used for the climate control of operating theatres must be carried out by specially trained personnel of the hospital maintenance department to prevent bacterial contamination of the air conditioners. Only in this way is it possible to safeguard the helath of all cleaning operatives, medical personnel and patients who enter the rooms in which the air conditoners are operated.

9.2 CLOTHING TO BE WORN DURING CLEANING OPERATIONS

Unless otherwise indicated by the doctor in charge of the surgical room, all cleaning personnel, in order to safeguard their own health as well as ensure successful result of the operations undertaken, must wear:

- Clean overalls
- Eye protection
- Latex rubber gloves (during cleaning and disinfection of the operating compartments, gloves must be changed as soon as they become dirty).
- Antiseptic mask
- Shoe covers

On completion of the cleaning operations, all the protective clothing worn must be disposed of as infected waste, except the overalls which may be used after washing and disinfection.

9.3 CLEANING SYSTEMS

As the air conditioners contain electrical components (electric motors, terminal blocks, sensors, etc.) that could be damaged by high pressure water jets or high temperatures, and a refriegeration system that must not be subjcted to high pressures, the use of steam or pressurised water jets for cleaning operations is strictly prohibited.

The water and disinfectant solution used to disinfect the appliance must only be used in the from of a nebulised spray. Use a manually operated sprayer to obtain a nebulised spray for air conditioner cleaning.

For washing and disinfection operations, use exclusively a 4% ammonium chloride and water solution (or a chemically equivalent commercial solution) applied using a manual sprayer.

Every air conditioner can be divided into three zones:

1) **TECHNICAL COMPARTMENT:** the part of the air conditioner containing the control systems and the compressors. In this zone there is no air circulation and therefore disinfection is not normally required. The technical compartment must be cleaned using a vacuum cleaner, with a renewable paper filter and a soft brush installed on the suction nozzle. Unless otherwise indicated by the doctor in charge of the room, used vacuum cleaner filters do not necessarily have to be disposed of as contaminated waste.

2) **OPERATING COMPARTMENTS:** the zone of the air conditioner containing parts where air treatment takes place. This zone is subject to a flow of external air to the operating room after suitable treatment, and to the flow of air returning from the operating room and expelled into the environment. Notwithstanding the filtration systems present in the air suction, retunn and distribution system and in the air conditioner itself, this zone may harbour bacteria which could proliferate when the unit is idle and thus create a health hazard when the unit is next used. These compartments must be washed and disinfected at least once a month or each time a surgical operation is performed that carries a risk of spreading harmful bacteria. However, as the frequency and manner in which operating rooms are used can vary greatly, the responsibility for deciding when washing and disinfection of these compartments is necessary rests exclusively with the person in charge of the medical department. Proceed as follows:
    - Remove the air filters before proceeding
    - Remove the pre-heating water coil (if present) as otherwise it could limit the effectivenss of any cleaning of the cold coil.
    - Wash the cold coil with sterilizing solution spray.
    - After re-installing the pre-heating coil, wash it usimg the same method.
    - Wash the heat recovery coils (if present).
    - Wash thoroughly the walls of the operating compartments, including those housing the fans.
    - Allow the unit to dry before refitting the filters.

3) **EXTERIOR OF THE AIR CONDITIONER:** the exterior of the unit is made from enamelled sheet steel and should only be cleaned in accordance with the criteria and the procedures specifically indicated in this manual. If the air conditioner is installed inside the operating theatre or in a communicating room (anaesthetic room, wake-up room, post-operative observation room, etc.), its exterior must be cleaned and disinfected at the same time as its operating compartments, unless otherwise indicated by the ward manager. If instead the unit is installed in a technical room not in communication with the operating theatre, it is sufficient to clean the exterior when traces of dust or grease are apparent

9.4 DISPOSAL OF USED CLEANING MATERIALS

The cleaning of the air conditioners produces both solid (old filters, operator’s clothing, worn drivebelts, etc.) and liquid waste materials (washing fluid residue and water used for rinsing).

The solid waste materials should be put into sealed containers and disposed of along with the contaminated hospital waste.

Liquid waste can be allowed to flow out through the drain outlets of machine’s condensate collection trays These trays are to be connected to the hospital's waste disposal system for hazardous liquid waste

10 FAULT DIAGNOSIS

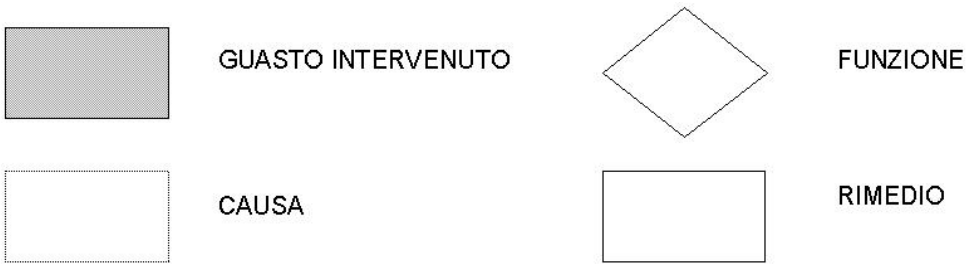
WARNING!
BEFORE CARRYING OUT ANY OPERATIONS ON THE UNIT, SET THE MAIN SWITCH TO POSITION "O"

This chapter contains information to assist the operator in tracing any faults that may arise with the machine Starting from a description of the nature of the problem, we provide indications on the probable causes and possible remedies. The description of the causes is generic and therefore takes into consideration the most complete versions of the machine; it is the task of the operator to determine which of the information provided applies to the machine in question.

All servicing and repair of the machine must be carried out by qualified personnel only.

We strongly recommend that you do not attempt any operations on the machine unless you have a good understanding of its operating principles.

Key to the fault diagnosis diagram:



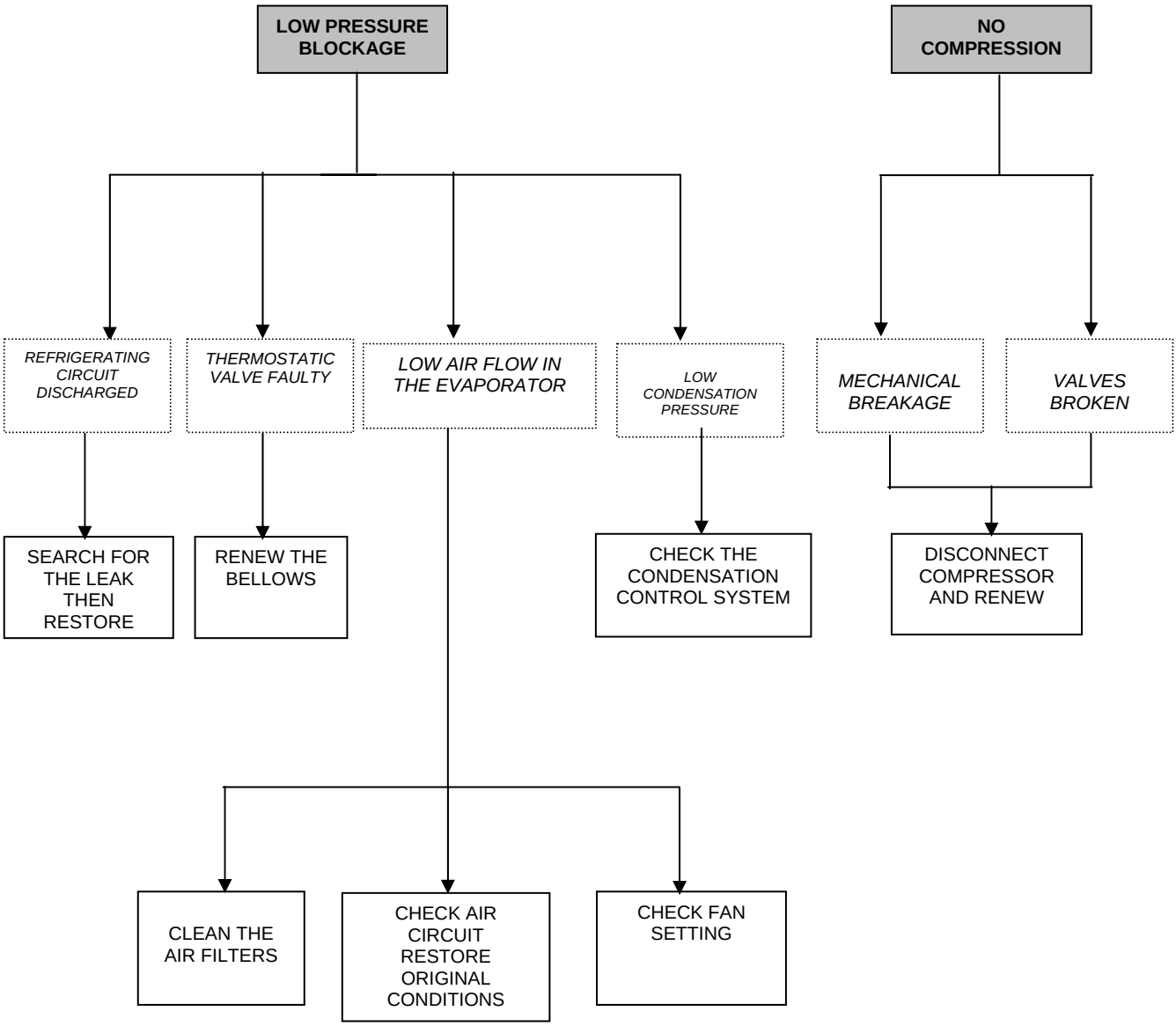
10.1 MALFUNCTION OF THE FAN CONTROL INVERTER.

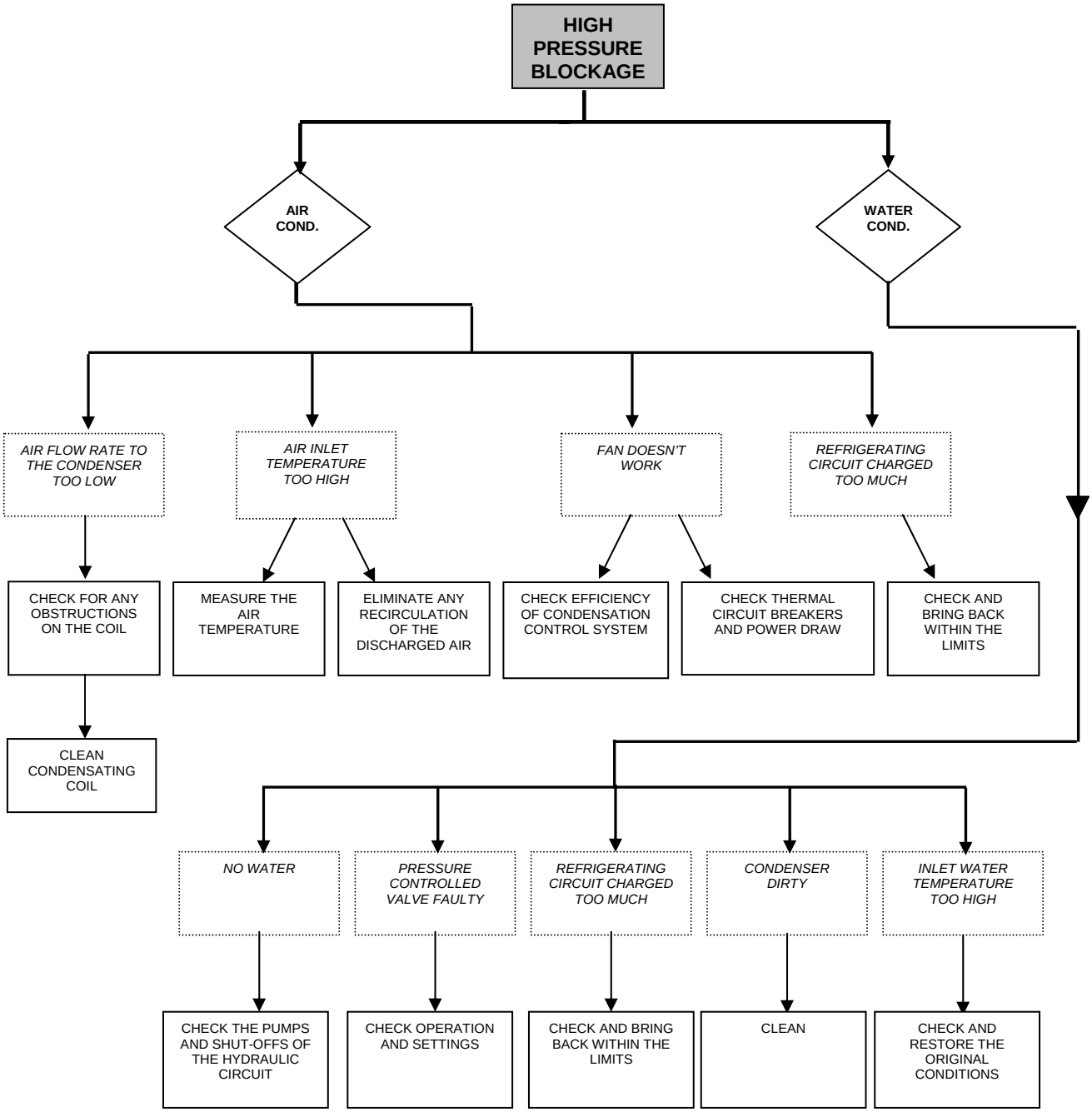
The following table lists the fault codes, the causes and the remedies for problems regarding fan control inverters.

CODE	FAULT	POSSIBLE CAUSE	REMEDY
1	**Overcurrent**	The inverter has detected that the current at the outlet terminals is too high (>4*IH) Sudden increase in load Short-circuit in motor wiring Unsuitable motor	Check the load Check the size of the motor Check the wiring
2	**Over-voltage**	The voltage of the intermediate DC circuit has exceeded the preset limits. Acceleration time too short High voltage surges in the supply line	Increase the deceleration time.
3	**Earth fault**	Current measurement has determined that sum of the motor phase currents is not zero. Faulty insulation of the wiring or the motor.	Check the motor wiring and the motor.
8	**System fault**	Component fault Malfunction	Remedy the fault and restart. If the fault recurs, contact our assistance centre
9	**Under-voltage**	The voltage of the intermediate DC circuit is below the preset voltage limits. Most probable cause: supply voltage too low. Internal inverter fault.	In the case of temporary interruption of the power supply, reset the fault and restart the inverter. Check the power supply voltage. If OK, the problem is due to an internal fault Contact our assistance service.
11	**Ouput phase supervision**	Current measurement has determined that there is no current on one of the motor phases.	Check the motor wiring and the motor.
13	**Inverter under-temperature**	The temperature of the heat sink is below –10°C.	
14	**Inverter over-temperature**	The temperature of the heat sink is greater than 90°C. The over-temperature alarm trips when the heat sink temperature rises above 85°C.	Check that the quantity and flow rate of the cooling air is OK. Check that there is no dust buildup on the heat sink. Check the ambient temperature. Check that the commutation frequency is not too high relative to the ambient temperature and the load on the motor.
15	**Motor stalled**	The motor stall protection has tripped.	Check the motor.
16	**Motor over-temperature**	The motor temperature model of the inverter has detected overheating of the motor. The motor is overloaded.	Reduce the load on the motor. If the motor is not overloaded, check the temperature model parameters.
17	**Motor underload**	The motor underload protection has tripped.	
22	**Checksum error EEPROM**	Failed parameters recovery Malfunction Component fault	Contact our assistance service.

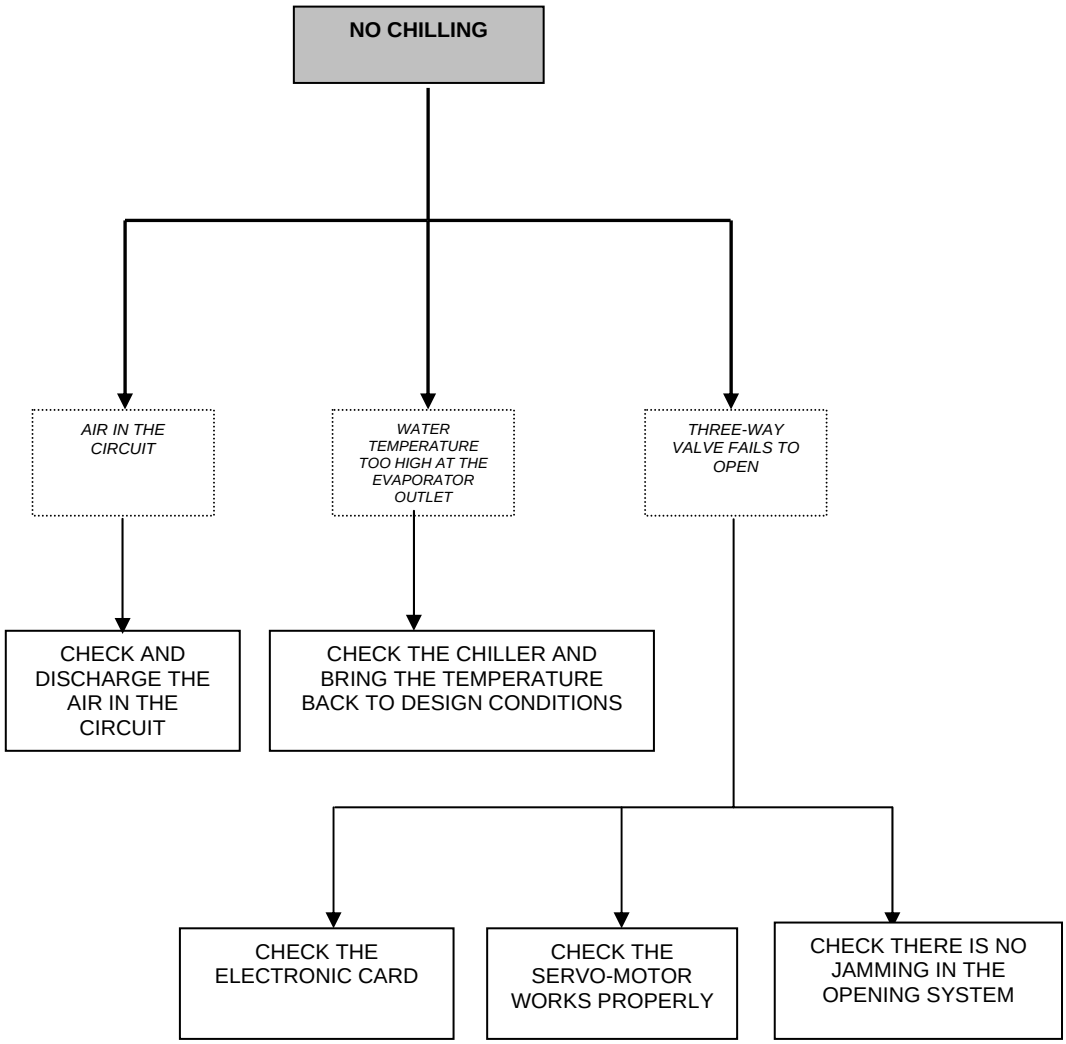
CODE	FAULT	POSSIBLE CAUSE	REMEDY
24	**Counter fault**	The value displayed on the counter is incorrect.	
25	**Watchdog faulty**	Malfunction Component fault	Reset the fault and restart. If the fault recurs, contact our assistance centre
29	**Thermistor fault**	The thermistor input on the optional board has detected an increase in the motor temperature.	Check the load and the cooling system. Check the thermistor connection (if the thermistor input of the optional board is not used it must be short-circuited).
34	**Internal communication bus**	Environmental interference or defective hardware.	Reset the alarm and restart. If this alarm code reappears, contact our assistance service.
41	**IGBT temperature**	The inverter IGBT bridge has detected an excessive overload current of brief duration.	Check the load Check the size of the motor
52	**Panel communication fault**	The connection between the control panel and the inverter is interrupted.	Check the panel connection.

10.2 DIRECT EXPANSION AIR CONDITIONERS – REFRIGERATION CIRCUIT PROBLEMS

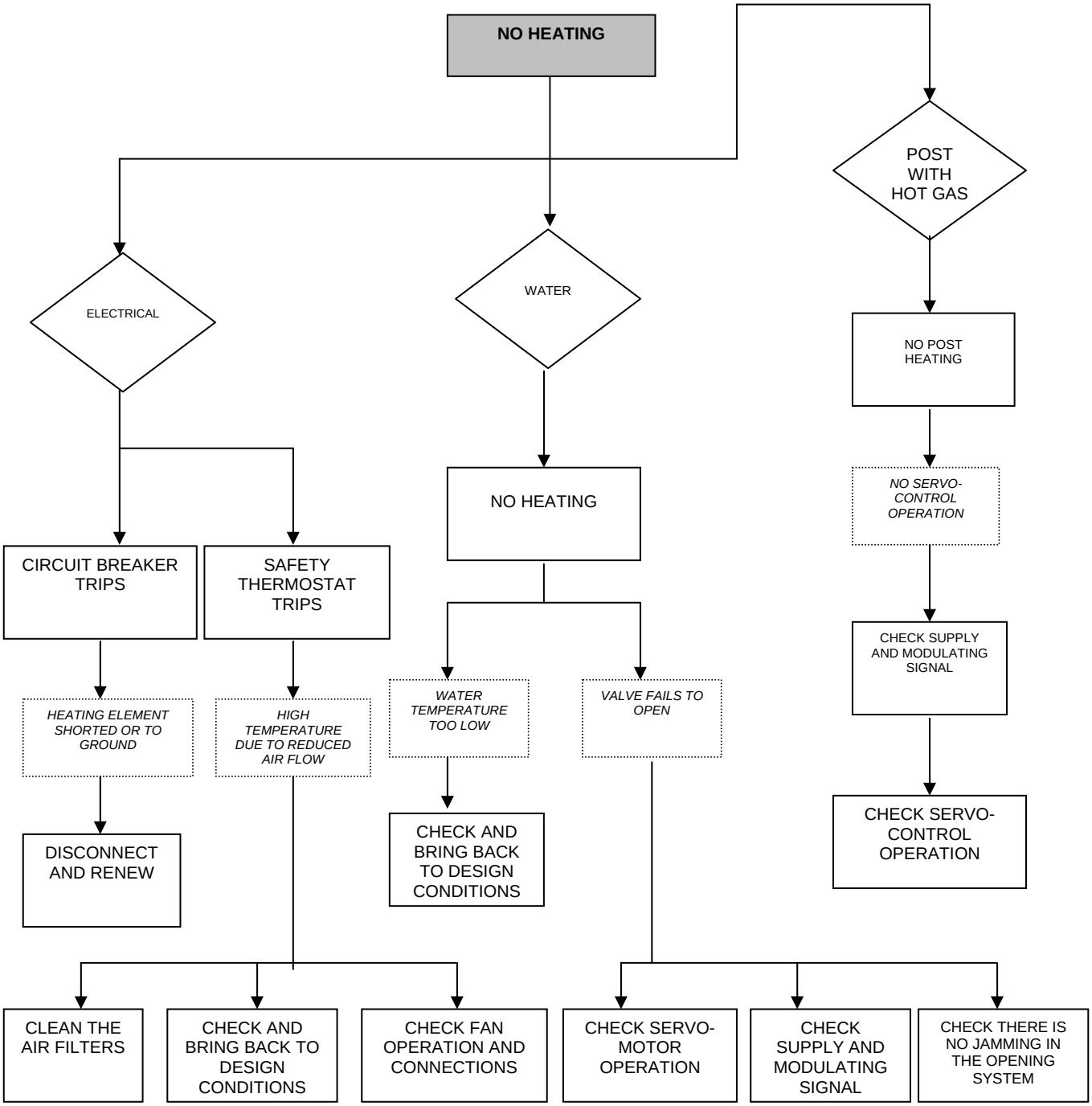



HIGH PRESSURE BLOCKAGE
AIR COND.
WATER COND.
AIR FLOW RATE TO THE CONDENSER TOO LOW
AIR INLET TEMPERATURE TOO HIGH
FAN DOESN'T WORK
REFRIGERATING CIRCUIT CHARGED TOO MUCH
CHECK FOR ANY OBSTRUCTIONS ON THE COIL
MEASURE THE AIR TEMPERATURE
ELIMINATE ANY RECIRCULATION OF THE DISCHARGED AIR
CHECK EFFICIENCY OF CONDENSATION CONTROL SYSTEM
CHECK THERMAL CIRCUIT BREAKERS AND POWER DRAW
CHECK AND BRING BACK WITHIN THE LIMITS
CLEAN CONDENSATING COIL
NO WATER
PRESSURE CONTROLLED VALVE FAULTY
REFRIGERATING CIRCUIT CHARGED TOO MUCH
CONDENSER DIRTY
INLET WATER TEMPERATURE TOO HIGH
CHECK THE PUMPS AND SHUT-OFFS OF THE HYDRAULIC CIRCUIT
CHECK OPERATION AND SETTINGS
CHECK AND BRING BACK WITHIN THE LIMITS
CLEAN
CHECK AND RESTORE THE ORIGINAL CONDITIONS

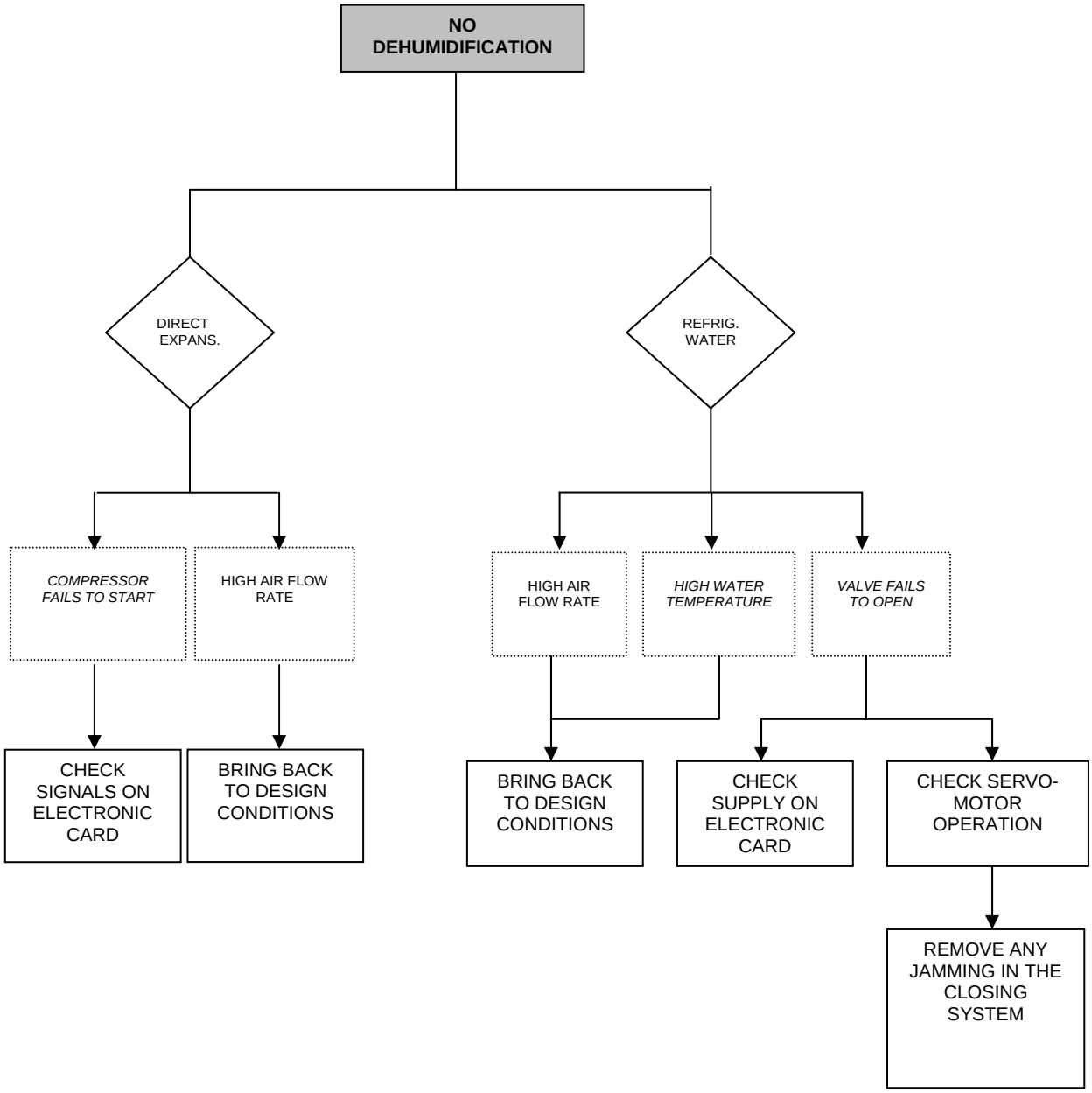
10.3 CHILLED WATER AIR CONDITIONERS – WATER CIRCUIT PROBLEMS

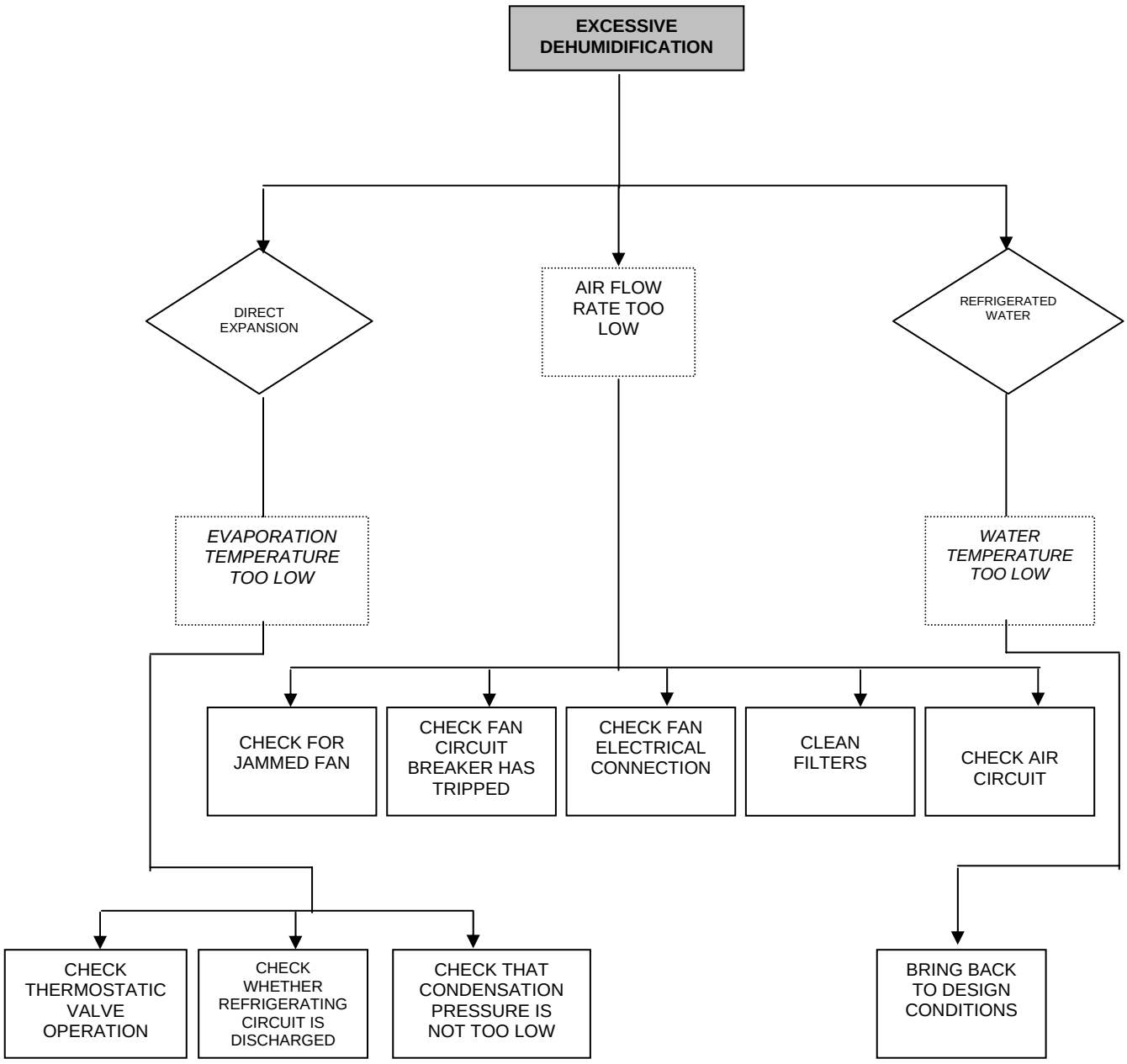


10.4 HEATING SECTION PROBLEMS

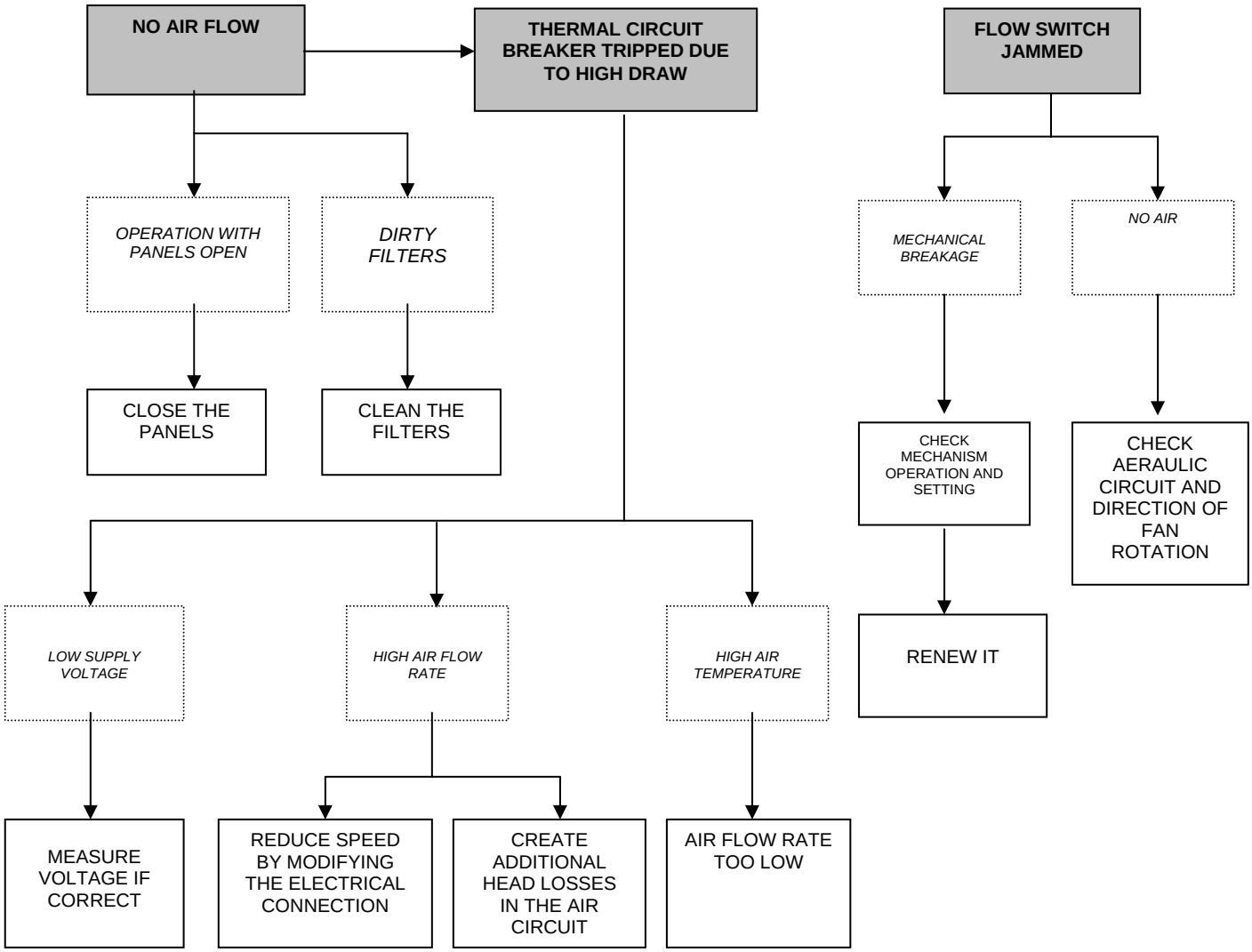


10.5 DEHUMIDIFICATION PROBLEMS




EXCESSIVE DEHUMIDIFICATION
DIRECT EXPANSION
AIR FLOW RATE TOO LOW
REFRIGERATED WATER
EVAPORATION TEMPERATURE TOO LOW
WATER TEMPERATURE TOO LOW
CHECK FOR JAMMED FAN
CHECK FAN CIRCUIT BREAKER HAS TRIPPED
CHECK FAN ELECTRICAL CONNECTION
CLEAN FILTERS
CHECK AIR CIRCUIT
CHECK THERMOSTATIC VALVE OPERATION
CHECK WHETHER REFRIGERATING CIRCUIT IS DISCHARGED
CHECK THAT CONDENSATION PRESSURE IS NOT TOO LOW
BRING BACK TO DESIGN CONDITIONS

10.6 VENTILATION PROBLEMS



11 GLOSSARY

- **Dead band – neutral band:** defines a very narrow temperature range between the set-point and the proportional band within which the control devices are not operated.
- **Default:** this term is used to describe the values (e.g. set-point and proportional band values) that will be automatically applied by the system if the operator fails to set them.
- **Modulating valve:** The modulating valve is controlled by a signal with voltage varying from 0 to 10 V.
- **Proportional band:** defines a temperature range of just a few degrees starting from the setpoint, within which the system operates the control devices.
- **Ramp:** the operating range of a modulating valve from 0% to 100%
- **Range:** range of values that may be assumed by a parameter.
- **Return – Suction:** air from the controlled environment returned to the air conditioner.
- **Screen page:** a page displayed on the screen.
- **Set-point:** defines the temperature (or humidity) value to which the control system is set; the system activates the hot or cold control devices until the temperature (or humidity) in the controlled environment matches the set-point.
- **Step:** defines an area of the proportional band (of temperature or humidity) within which a device is switched on and at the same time defines the values at which the device is switched on and off.
- **Supply:** the air delivered to the room by the air conditioner.

12 NOTES